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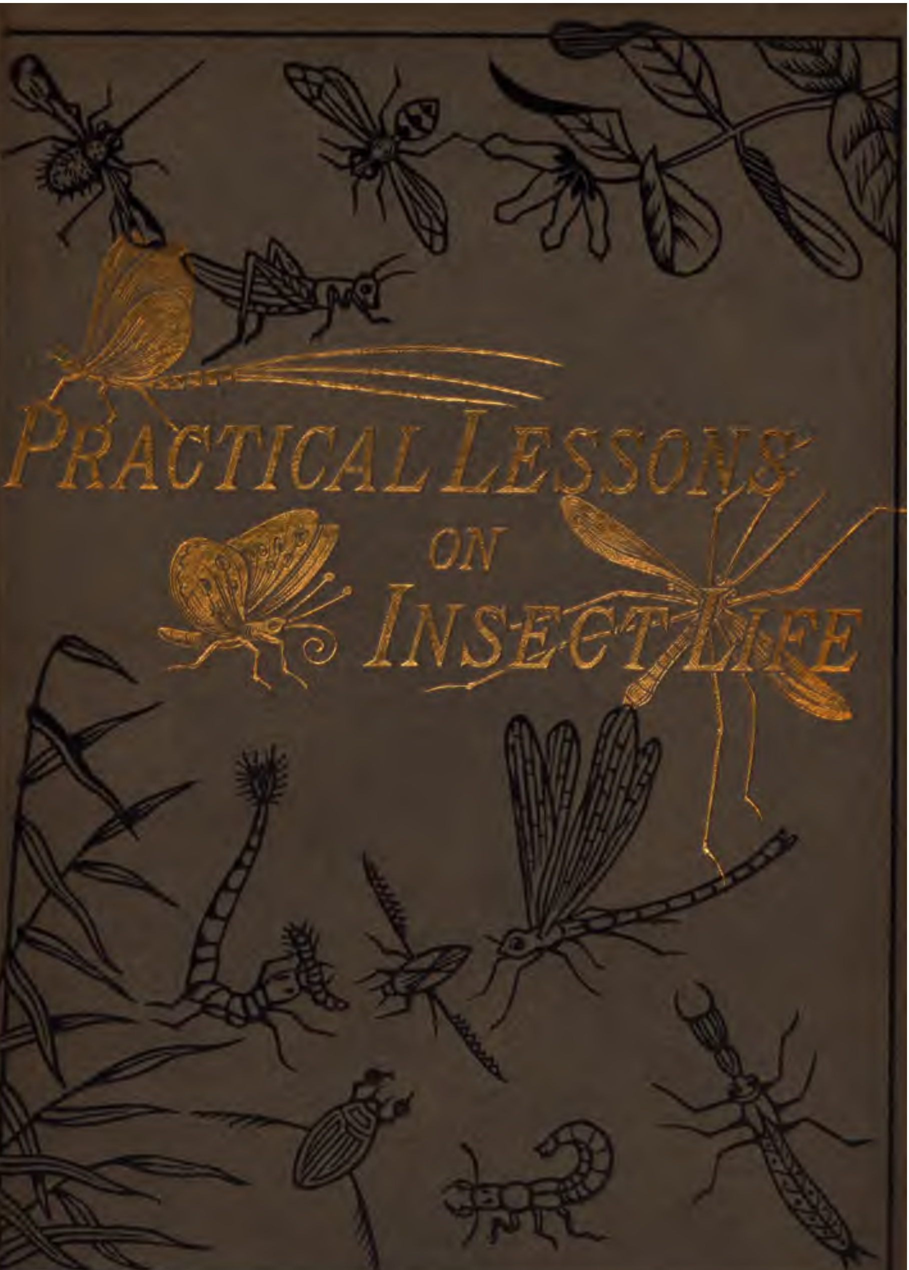

PRACTICAL LESSONS ON INSECT LIFE

BY THEODORE WOOD, M.E.S.

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THEODORE WOOD, M.E.S.,

Joint Author of "The Field Naturalist's Note-Book," and "Hughes's Illustrated Anecdotal Natural History."

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Practical Lessons on Insect Life.

BY THEODORE WOOD, M.E.S.,
Joint-Author of 'The Field Naturalists' Handbook.'

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I.—WHAT IS AN INSECT.

AT the commencement of these papers on Insect Life, it will be as well that we should have a settled idea as to what an insect is, and I shall therefore, in this opening article, endeavour to point out the chief characteristics of insects, and show how they may be distinguished from other classes of animals.

In the first place, insects belong to the great group of animals which are known as *Annulata*, or those whose bodies are composed of a number of rings, or 'segments.' In the insects, the number of these segments is invariably thirteen.

Each of these segments is composed of two half-rings, placed one above the other, and connected by an elastic membrane, which is capable of considerable expansion. The reason for this structure we shall presently see.

Besides the division into thirteen segments, the body of an insect is boldly divided into three chief portions, known as the *head*, containing the mouth and organs of sensation; the *thorax*, bearing the organs of locomotion; and the *abdomen*, containing the vital organs. This division into three portions constitutes one of the chief characteristics of the insect, and the word In-sect, *i.e.* cut-into, refers to this division. The Greek word *entomos*, from which is formed the word entomology, has the same signification. All insects, too, after being hatched from the egg, pass through two preliminary stages, viz. the larva, caterpillar, or grub, and the chrysalis or pupa, before attaining their perfect condition. These stages, which are technically termed *metamorphoses*, will be more fully described in the succeeding paper.

Another important distinction is that all insects have six legs, neither more nor less, though in some cases they are not all fully developed. It is thus easy to see why spiders do not rank as insects, in spite of the popular notion to the contrary; for, in the first place, the body is divided into two chief portions only, the head and thorax being fused into one, called the *cephalo-thorax*, or head-thorax, which combines the functions of both parts. Besides this, they have eight legs instead of six, as well as several other minor differences.

Of the thirteen segments which make up the body of an insect, the HEAD is the first, and contains the mouth and the organs of the various senses, which we will examine in turn.

The mouth is found in various forms, each being most suitable to the food which the insect consumes. The beetles and many other insects, for instance, are provided with a pair of powerful horny jaws, often more or less toothed, which invariably work from side to side, instead of up and down, as is the case in the higher animals. Placed beneath these jaws is a pair of lesser size, known as the *maxillæ.*

Some insects, such as the butterflies and moths, are furnished with a flexible tube, which can be inserted into flowers, and their juices sucked up into the mouth by its means. This organ is usually known as the trunk or *proboscis*, and is not merely a simple tube, as might perhaps be imagined. In reality, it is formed by two separable half-tubes, composed of innumerable joints, and connected to each other by means of a series of small hooks, the two portions thus forming a complete tube, through which liquid nourishment can be imbibed. While not in use, the proboscis is usually coiled away beneath the head. Its structure may be readily examined by procuring a recently-killed moth or butterfly, and drawing the organ out with a pin or other instrument. If care be taken, the two portions may be separated, and their structure investigated by means of a microscope or powerful magnifying-glass.

Many insects, besides being furnished with a proboscis (which, in these cases, is not capable of being coiled up), have a further apparatus, consisting of a series of lancets, for the purpose of piercing the skin before proceeding to imbibe the blood. In the common gnat this structure is strongly exemplified.

Connected with the mouth are two pairs of feelers, varying greatly in size and form, which are termed *palpi;* the first pair, situated upon the maxillæ, or lesser jaws, being termed in consequence the maxillary palpi; and the second pair, placed on the labium, or lip, the labial palpi. Their use is supposed to consist in investigating the substances upon which the insect feeds. In many insects they are very imperfectly developed.

The eyes of insects are of two kinds, simple and compound, both forms being generally found in the same insect. The compound eyes, two in number, are placed one upon each side of the head. They are always more or less convex, and are composed of a considerable number of lenses, varying from twenty-five in each eye in certain species of ants, to about eighteen thousand in some of the butterflies. Each of these eyes is hexagonal in form, and possesses a perfect visual apparatus, so that some insects are furnished with the astonishing number of thirty-six thousand distinct eyes. Of course, it is not to be supposed that each of these eyes produces a separate impression upon the optic nerves; and as the eyes are immoveable, it is probable that one only, or at any rate a very small number of the facets are in focus with any given object at the same time. Hence the want of moveability is compensated for by the number of lenses, each of which points in a different direction, and commands a separate field of vision.

The simple eyes are usually very few in number, and are generally situated upon the upper surface of the head. Though both forms are generally found in the same insect, this is not always the case, sometimes the one and sometimes the other being alone found. Some few insects, indeed, among them several of the beetles and exotic ants, are entirely without eyes of either description.

Though it is undoubtedly the case that many, if not all insects, possess the sense of smell, it is yet unknown where the organs of scent are placed. The various carrion-feeding insects, for example, evidently detect the presence of their food by its odour; moths, and many other insects, which feed upon the sweet juices of flowers, must do the same; yet, although many theories have been advanced upon the subject, we have still to detect the organs devoted to the sense.

Neither have the organs of hearing been satisfactorily identified, unless, perhaps, the antennæ perform those functions. Yet the sense must be there, for many insects—as, for instance, the grasshoppers and crickets

—evidently possess the power of appreciating sound and communicating by its means.

We invariably find upon the head of an insect two organs, varying to a great extent in form and size, which are popularly known as 'feelers,' or 'horns,' and scientifically as *antennæ.* They are composed of a number of joints, but are perfectly dissimilar in various insects. In the butterflies, for example, they are slight and thread-like, until within a short distance of the end, where they suddenly enlarge into a knob. Among the moths, they are sometimes entirely thread-like, and sometimes heavily plumed, either for part or the whole of their length. This plumed structure is often found in the male, and the simple in the female of the same insect. In ants, some of the beetles, etc., they are strongly elbowed, and so on.

Their uses have never yet been discovered, some observers considering them to be the organs of the sense of smell; others, of that of touch; while still others suppose them to be the seat of some sense not possessed by and unknown to man. It is certain that they have the power of communicating impressions to the mind of their owner, as no one can for a moment doubt who has seen an ant examining an obstacle carefully with its antennæ before proceeding upon its way.

Passing to the second of the chief divisions of the body, namely the THORAX, bearing the various organs of locomotion, we find that it again is subdivided into three portions. Of these, the first, or *pro-thorax,* bears the first pair of legs; the second, or *meso-thorax,* the second pair of legs, and the upper pair of wings, and the half of the last pair of legs; the last, or *meta-thorax,* bears the lower wings, and the other half of the last pair of legs.

The legs are formed of joints, corresponding somewhat to those of our own limbs, and therefore named in accordance with them, viz., the *femur*, or thigh, next the body; the *tibia*, or leg; and the *tarsus*, or foot. This last usually consists of five joints, terminated by either a single or a double claw. The place of the hip-joint is taken by the *coxa*, which performs much the same functions.

The wings are formed of a transparent membrane, stretched between stout ribs, or *nervures*, of a strong, horny substance, which usually branch off and connect with each other in such a way as to form a perfect network. The whole structure is a wonderful combination of lightness and strength.

In many insects, and more especially the butterflies and moths, the wings are thickly covered with scales, which are most exquisitely sculptured and variegated, although so small that a powerful microscope is necessary to reveal them as anything more than a slight dust upon the wings. They are arranged in rows, one slightly overlapping the other, like slates on the roof of a house, and are but loosely fastened to the wing, a very slight touch being sufficient to detach them from their position.

In the beetles, the upper pair of wings are entirely of a horny consistency, and are not used in flight, being merely employed to protect the under pair which are folded away beneath them while the insect is at rest. In the *diptera*, or two-winged flies, the upper wings alone are developed, the lower pair being merely represented by a couple of small knobs, termed *halteres*, or balancers, which assist in preserving the equilibrium of the body while the insect is upon the wing. In some cases, all four wings are rudimentary only, and are totally incapable of being used in flight.

The ABDOMEN, consisting of the remaining nine segments, contains the vital organs.

WHEN we come to examine the internal structure of an insect, we find it to be so different to what we might expect from an acquaintance with the higher forms of animal life, that we should hardly recognise the various organs in their simpler and less developed forms.

Insects possess neither skeleton, heart, lungs, nor brain, as we understand the words, the whole structure being essentially unlike that of the vertebrate animals.

The place of the skeleton is taken by the hard shell of the insect, which provides the necessary strength and rigidity, while the elastic membrane by which the segments are connected allows the body to be curved in any required direction, thus performing the office of joints.

The mass of nerves, which answers the purpose of a brain, runs for almost the entire length of the body, and consists of a number of nerve-bunches, or *ganglia*, generally one to each segment, connected with each other by nerve-chains. On account of this structure, an insect can receive with comparative impunity injuries which would be instantaneously fatal to animals of a higher order of being, for almost every separate nerve-centre must be destroyed before life is fairly extinguished.

From each of these ganglia, branches are sent out to the various parts of the body, but the whole nervous system is of a very slight and imperfect character.

In place of the heart and other circulatory apparatus, we find in the insects a single blood-vessel only, which runs along the back for almost the whole length of the body. This is termed the dorsal vessel. and is furnished with valves at intervals, which regulate the passage of the blood. This dorsal vessel pulsates, although slowly; the blood, after leaving it, passes among the various organs of the body, until it re-enters it at the former end.

The dorsal vessel can easily be examined in any of the smooth and thin-skinned caterpillars, in which it will be seen as a pale streak running along the back. By the aid of a magnifying-glass the pulsations may even be noticed.

The breathing apparatus is constructed upon entirely different principles to that of the vertebrate animals. Instead of nostrils, the insect breathes by means of a series of holes, or *spiracles*, placed along the sides of the body, which open into two large tubes, or *tracheæ*, running for the whole length of the body.

Upon examining one of these spiracles under a microscope, it is seen to be fringed with stiff, elastic, bristly hairs, interlacing with each other in every direction, and effectually preventing the ingress of anything except air. They are usually eighteen in number.

From the tracheæ are thrown off innumerable branches, which permeate every part of the body, penetrating even to the tips of the antennæ and claws. Now we see the reason for the structure of the segments above mentioned, the elastic membrane connecting the two half-rings allowing the body to be expanded and compressed, the air being thus drawn into every part of the breathing system, and expelled in turn.

On account of this wonderful labyrinth of tracheæ, an insect is particularly liable to the effects of any poisonous odour, which, at a single inspiration, is inhaled into all parts of the body, and is quickly fatal. From the same cause, an insect which is unfortunate enough to fall into any greasy liquid is instantly killed, the grease clogging the spiracles and preventing the admission of air into the tracheæ.

The structure of these tracheæ is especially worthy of notice.

One would naturally imagine that when the joints of the limbs are bent, the tubes which supply them would be closed, and the passage of air prevented. Not so, however, for all these tubes are double, one being placed within the other, and between them and surrounding the inner one is coiled a long, stiff, bristly wire, just as is the case in our flexible gas tubes. By this arrangement, a joint can be bent double and the tube yet retain its circular form, the coiled bristle keeping it constantly open. A somewhat analogous structure is found in our veins and arteries, through which the blood passes equally well whether the limb be extended or bent.

The digestive organs are, as regards the general principle, much the same in all insects.

From the mouth, of course, runs the gullet, or *œsophagus*, a very slight and narrow tube, which leads to the stomach. In many insects, however, the food, before arriving in the stomach, is passed into a membranous bag, known as the *sucking-stomach*, and sometimes, but erroneously, as the crop, where it is prepared for digestion. In those insects, also, which derive their sustenance from materials of a hard or tough nature, at the entrance of the crop is found an organ especially adapted for the due mastication of the food, and which, from its analogy to the corresponding organ in fowls, etc., is usually termed the *gizzard.* This varies greatly in form in different insects, but usually consists of six or eight large and powerful jaws, armed with a considerable number of small teeth, which in the cockroach average nearly six thousand. By these numerous teeth the food is masticated, until it is in a fit condition to pass into the stomach, which is merely a large membranous bag surrounded with bands of muscular fibre.

At the junction of the stomach with the intestines is found a mass of fine whitish threads, looking, when some insects are under dissection, like a small piece of cotton wool. Upon carefully drawing out and examining these threads, each is found to be a separate tube, closed at one end, the whole apparatus fulfilling the important functions of the liver. This structure is of the greatest importance to physiologists, proving, as it does, that the primary form of a gland is a simple closed tube.

Having now briefly described the general structure and chief characteristics of the insects, I shall, in the next article, treat of their life-history before they arrive at their perfect condition.

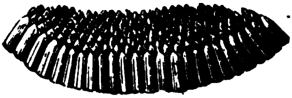
II.—THE METAMORPHOSES OF INSECTS.

AS was mentioned in the preceding article, every insect passes through a series of changes, or more properly speaking, *metamorphoses*, before arriving at its perfect condition. These stages, three in number, are known as the egg; the larva, grub, or caterpillar; and the pupa, nymph, or chrysalis, the last of which terms, however, is only employed in the case of certain butterflies. We will now proceed to follow the insect through these developments.

In the first place, of course, we have to deal with the egg. In colour, size, and shape, the eggs of insects vary to a most wonderful degree, scarcely two forms being alike, and those of the most closely allied species often being totally different from each other. Some are plain, others chased and sculptured, covered perhaps with a raised network of wonderful intricacy, and enriched with all the colours of the rainbow. Some are round, others oval, square, oblong, or pear-shaped, while there is no limit to the patterns displayed upon them.

In point of numbers and situation, too, the eggs vary very greatly. A very curious arrangement is found in the common gnat.

The eggs of this insect greatly resemble a small skittle in shape, and are fastened together in considerable numbers, the whole batch forming a very perfect boat, which floats upon the surface of the water, and which cannot be upset or sunk by any accident. Even when forced beneath the water, it rises again to the surface as soon as it is released, and emptying out the water it has taken in, floats uninjured as before. In fact, the structure irresistibly reminds the observer of the most perfect life-boat which can possibly be imagined. These egg-boats, which are about the size and shape of a carraway seed, may be found in numbers in almost any rain-water tub throughout the summer.

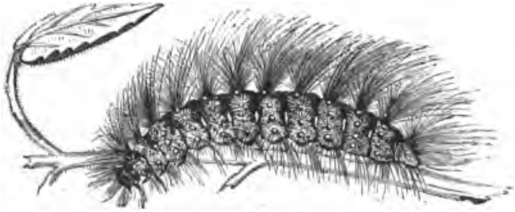


Eggs of Gnat.

As a general rule, the eggs are laid by the parent insect either upon or near the food of the future larvæ, and after a lapse of time varying according to the insect, the enclosed grubs break through their cell and make their way into the outer world.

Almost as soon as they are hatched, the young larvæ begin the grand business of their lives, namely, eating, and in many cases make their first meal upon the empty egg-shell from which they have just emerged. From that time until their change into the pupal condition, they eat almost without cessation; and it has been computed that an insect, during this part of its existence, consumes more than one hundred thousand times its whole weight in food. And the reason is this, that the whole growth of the future insect takes place while it is in the larval state. It is an invariable rule that no insect ever grows when once it has attained its perfect condition, in spite of the popular notion to the contrary. The general idea is, that all small insects are necessarily young, and that as they grow older they will increase in size. So, a house-fly is considered to be merely a juvenile blue-bottle, and a gnat is expected to develop in due course of time into a daddy-long-legs, and so on, and it is often very difficult to persuade people to the contrary.

Another argument frequently brought forward in favour of the growth of insects is, that one often sees specimens of the same insect varying greatly in point of size. This is true enough; but both being perfect insects, will remain of the same size until they die; and it would be as reasonable to infer that the smaller might attain the dimensions of the larger, as it would be to state that a dwarf would grow into a giant. There are large insects and small insects, just as there are large and small men.



Larva of Tiger Moth.

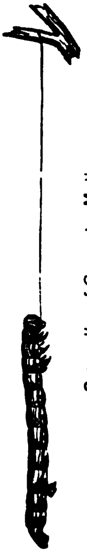
Now, taking into consideration the enormous quantities of food which a caterpillar requires, it necessarily follows that his increase in size must be proportionately rapid. And there is this drawback, that after a certain degree the skin will expand no further, and, although the creature is still obliged to continue eating, becomes most inconveniently tight. Now what is he to do? Eat he must, and his skin will stretch no further.

There is only one thing for him to do, namely, to burst, and this he accordingly does. The old skin splits down the back, and after a little trouble the caterpillar, clad in a bright new covering, crawls out from his old integument, which, as often as not, he immediately devours. No sooner has he recovered from his exertions than he again begins feeding, and continues to do so until his increase in size renders necessary another change of garments.

This operation takes place as a rule from four to six times during the life of the caterpillar, each operation consuming from twelve to twenty-four hours.

The forms of the larva are as various as those of the egg. We can hardly take a country walk in the early summer without noticing on the leaves of the nettle a number of brown hairy caterpillars, generally known as 'woolly bears.' These will in course of time develop into the well-known Tiger Moth. A little farther on, perhaps, we may find a group of black caterpillars thickly covered with stiff spines, which will later on become 'Peacock' Butterflies. Beneath the leaves, or hiding at the roots of the weeds, may be dug out a variety of perfectly smooth caterpillars, belonging to various moths. From almost any tree we may knock out a number of thin, stick-like objects, generally hanging at the ends of long silken threads, and which are also caterpillars.

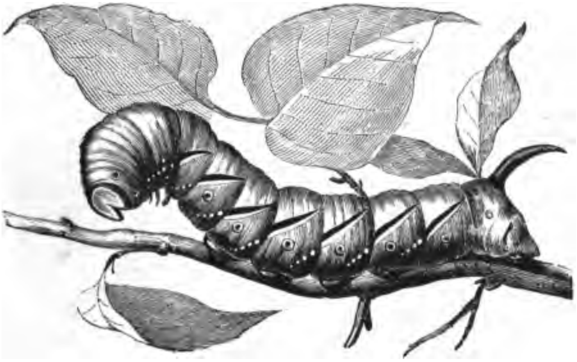
Then, a little later on in the year, will very likely be seen the larvæ of some of the Hawk Moths, such as the one represented in the accompanying illustration, and which are armed with a long curved horn at the end of the body, together with many more far too numerous to mention.



Caterpillar of Geometer Moth.

The larvæ of other orders of insects, too, present still other forms; but as merely to describe some of the more conspicuous would more than fill the entire space assigned to this article, I shall confine myself to those of the more generally known butterflies and moths.

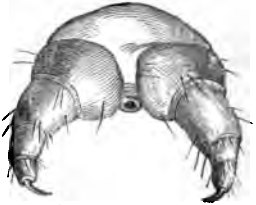
Upon examining the structure of one of these caterpillars, it will be seen that it possesses all the chief characteristics of the insects. It is now, just as in the perfect state, composed of thirteen segments, and the legs correspond in number.



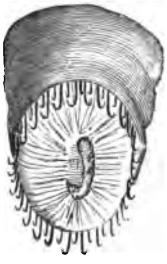
Larva of the Privet Hawk Moth.

The organs of the various senses are not developed to an equal degree with those of the perfect insect. Instead of the enormous compound eyes, with their thousands of lenses, a caterpillar is limited to a few simple ones, twelve in number, which are placed six upon each cheek close to the mouth, and are so highly convex that they can convey no impression to the optic nerves unless brought almost into contact with an object. The antennæ, too, are very small.

Besides the six true legs, which answer to those of

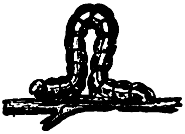


Legs of Caterpillar.



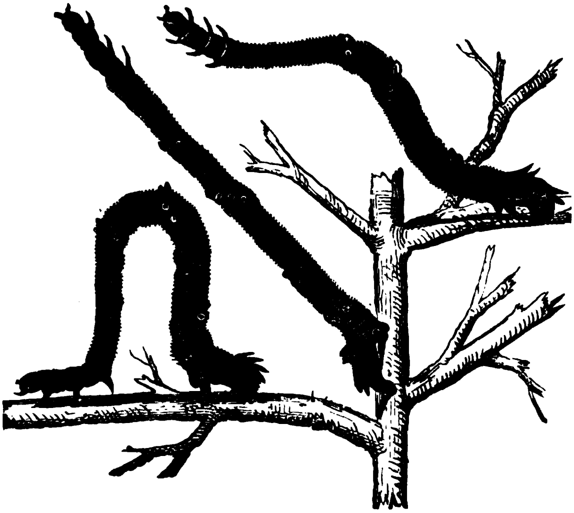
Clasper of Caterpillar.

the perfect insect, and are placed upon the same segments, a caterpillar is furnished with several false legs, or claspers, varying from four to ten in number. The difference between the two forms is very marked. The true legs are jointed, just as is the case in the perfect insect, and are provided with hooks or claws for the purpose of obtaining a firm foothold. The claspers, however, are nothing more than mere fleshy pads, surrounded by a circle of small but strong hooks, with the points directed inwards, and formed in such a manner that the air can be exhausted and a vacuum formed, just as is the case in the well-known 'sucker,' so common as a toy. The grasping power of these claspers is very great, and it is quite impossible to forcibly remove many larvæ from their footing without either severely damaging or killing them outright.



Geometer Larva. Mode of Walking.

In the larvæ of the *Geometræ*, or Looper Moths, the three first pairs of claspers are wanting, the remaining two pairs being situated at the very end of the body, and in consequence the caterpillars proceed in a very extraordinary manner. Grasping firmly the leaf or twig upon which it is resting with the true legs, the creature arches its body double, plants the four claspers immediately behind the feet, and taking a firm hold with them, extends the body to its utmost length in front. A second grasp is then taken with the legs, the body arched, and the claspers drawn up as before, and so on.



Larvæ of Geometer Moth.

These larvæ have a curious habit when at rest of grasping a branch by the claspers alone, and stretching out the body at right angles to it, when from their colour and markings they bear so close a resemblance to a small twig that the most practised eye will often fail to detect them.

The interior anatomy, also, of a caterpillar is well worthy of examination. As a general rule, people do not seem to think that caterpillars have any internal organs, and this popular idea was well summed up by a gentleman who, on seeing one dissected for the first time, was astounded, and said that until then he had always thought that they were 'nothing but skin and squash'!

Living practically for no other purpose except eating, the interior is almost entirely occupied by the digestive organs, and upon opening a larva the first idea would probably be that it was all stomach, with a coating of fat. And, in point of fact, the stomach occupies about nine-tenths of the available space, the rest of the digestive organs being very slight.

The circulatory nerves and respiratory systems are much the same as in the perfect insect, but are more easily examined.

A point of the structure of the larva not possessed by the perfect insect is found in the silk glands. These are two in number, one upon each side of the body, and are provided with ducts, which unite in the spinneret, an organ of the simplest description.

The silk, while still contained in the glands, is merely a rather thick, viscous fluid. When about to make use of it, the caterpillar places the spinneret in contact with some object, exuding at the same time a drop of the liquid, and sharply withdraws it. The silk immediately hardens upon exposure to the air, and is drawn out into an exceedingly fine but strong thread, which is able to sustain the whole weight of the caterpillar without giving way.

This silk is used for various purposes. At the approach of danger, many species of caterpillars allow themselves to fall from the branches and hang at the end of their threads until it is past, trusting to their resemblance to pieces of twig to deceive any hungry bird. Others, gregarious in their habits, spin huge webs in which to reside; others, again, bend the edges of leaves together and fasten them by its means. Some few, such as the larvæ of the well-known Puss Moth (*Dicranura vinula*), construct a silken pad as a foothold for the claspers. But its chief use is in forming the cocoon, the common silkworm being as good an example as could be desired. It is not always used alone, many insects mingling scraps of wood, bark, etc., with it, and forming a cocoon almost hard enough to turn the edge of a knife.

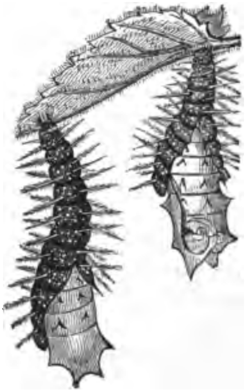
The time passed in the larval condition varies according to the insect, and is also much influenced by the condition of the weather, a warm season accelerating and a cold one retarding the growth. Some insects pass through the whole of their development in a few hours, while others, such as the Goat Moth (*Cossus ligniperda*), remain in the larval state alone for upwards of three years.

During all the earlier stages of their life, insects seem to possess an almost unlimited power of enduring cold. Caterpillars have been exposed to a temperature of some twenty or thirty degrees below zero, and have been frozen so hard that, when touched, they snapped asunder like glass; yet, upon the surrounding atmosphere being raised to the normal temperature, they revived, and seemed none the worse for their experience. Many pupæ, too, which lie fully exposed to the elements during the winter, will pass through the severest frosts without injury. It is often said that a cold winter will be good for the crops, as great numbers of the insects which devour them will be killed by the cold. In reality, however, it is rather the other way; for, while the insects are uninjured, the small birds which prey upon them perish in hundreds for want of food, so that, when the warmer weather arrives, the insect pests perform their ravages comparatively untroubled by their feathered enemies. Wet, however, insects cannot endure and a very damp autumn always produces a most perceptible effect upon the abundance of insects during the ensuing summer.

The food of larvæ is as varied as their forms. There is scarcely a plant or tree which does not afford sustenance to many caterpillars, either by means of the foliage or the wood itself. Even the very roots furnish food to many species. Such repulsive substances as carrion, the droppings of animals, etc., are the resort of thousands of insects, to whose unceasing labours we are indebted for the prevention of many noxious diseases.

In fact, there is hardly any place in which insects may not be found, or any substance upon which their larvæ do not feed.

Some two or three days before its change into the pupal condition, the caterpillar ceases feeding, and becomes sluggish and irritable. It then seeks a place in which to undergo its transformation, and where it may be safe from the attacks of enemies. After a time, the skin splits down the back, and the pupa appears beneath. By means of sundry wriggles and contortions the larval skin is at last got rid of, and the pupa then lies quiescent until the time approaches for the enclosed imago to escape. During this time it is nourished by the stores of fat which it laid up while it was still a caterpillar, just as hibernating animals subsist upon their accumulated fat during their period of inactivity.

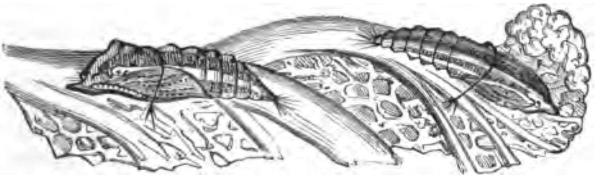


Chrysalides.

In the preceding illustration will be seen two different stages of the transformation, the first being taken soon after the commencement of the operation, and the second when, by its struggles, the chrysalis has almost succeeded in freeing itself from its larval covering.

The larvæ of many insects bury themselves beneath the earth in order to undergo their change, generally choosing some sheltered situation, such as the roots of a tree. Some suspend themselves by the tail to a leaf or twig; others from a silken cocoon, often mingling earth, wood-chips, and similar materials with it in order to render it less conspicuous; others, again, fasten themselves to some object by means of a silken band round the body, and so on.

In the *Lepidoptera*, or butterflies and moths, and many other insects, the pupa is entirely without the means of locomotion, and remains in a state of perfect quiescence until the time arrives for the perfect insect to break forth. But in many insects, notably the dragon-flies and others, whose earlier stages are passed beneath the water, the pupal form differs in but a slight degree from the larval, and still retains the power of locomotion, the whole habits of its life, indeed, being but little altered.



Pupa of Pieris brassicæ.

No. III.—THE ORDERS OF INSECTS.

IN order to facilitate the classification of Insects, they are divided into various groups, or *orders*, according to their differences of structure. Various systems have been employed by different authors, but the arrangement now about to be described is that generally in use at the present day, and which is based on the structure of the wings.

At the head of the insects stand the beetles, or *Coleoptera*, they being the most highly developed of the tribe. Their leading peculiarity is that of the four wings possessed by them: the upper pair are of a firm, horny nature, and are not used in flight, being merely employed to protect the lower pair, which are packed away beneath them. The name *Cŏleŏptera* refers to this structure, being derived from two Greek words, the one signifying a sheath, and the other a wing—'sheath-wings.' When the insect is at rest these wing-cases, or *elȳtra* as they are more properly termed, do not overlap each other, but meet in a straight line continued for the whole, or nearly the whole, of their length. This line of junction is usually known as the 'suture.'

The wings themselves are, when present, invariably larger than the elytra, and, when not in use, are folded transversely, and packed away beneath them. Many beetles, however, only possess the merest rudiments of wings, and in such cases the elytra are always soldered together. In one or two species both elytra and wings are almost entirely wanting.

The *Coleoptera* are provided with jaws, and subsist chiefly upon food of a solid nature.

As regards the earlier stages of development, the larvæ of the *Coleoptera* are soft, with the exception of the first two segments of the body. They are provided with six legs, corresponding with those of the perfect insect, and placed upon the same segments, namely, the second, third, and fourth. During the pupal state the insects of this order are inactive, and take no nourishment. The limbs are enclosed in the outer covering, just as is the case in the *Lepidóptera.*

Owing to the difficulty of watching the *Coleoptera* during the earlier stages of their life, the nature of their habits rendering it almost impossible to rear them in captivity, the life-histories of the order are but little known.

The next order consists of the *Euplexóptera*, or *Dermáptera* as they were formerly termed. The first of these titles is formed from three Greek words, signifying 'préttily-folded-wing,' the manner in which the lower pair of wings are packed away beneath the upper being simply marvellous. The older title, *Dermaptera*, signifying 'skin-winged,' referred to the structure of the elytra.

The insects composing the order are popularly known as 'Earwigs,' and are usually held in great detestation, partly on account of the pair of forceps with which the end of the body is provided, and partly owing to the prevalent idea that the creatures are in the habit of crawling into the human ear, reaching the brain, and driving the victim mad. In reality, the earwigs are perfectly harmless; for they possess no sting, they do *not* crawl into people's ears, and the tail-forceps, which are used in packing the wings be neath the elytra, are quite unable to inflict any injury upon the most delicate skin.

The earwigs were formerly included in the following order, the *Orthóptera*, but were separated on account of the manner in which the wings are folded.

In the *Orthoptera*—'straight-winged' insects—the upper wings, or elytra, are only partly horny, and are stretched upon strong nervures which supply the necessary rigidity. When not in use, these overlap each other, instead of merely meeting as is the case in the beetles. The hind wings are folded longitudinally, instead of transversely. The jaws are formed for cutting vegetable substances, upon which the greater number of these insects feed.

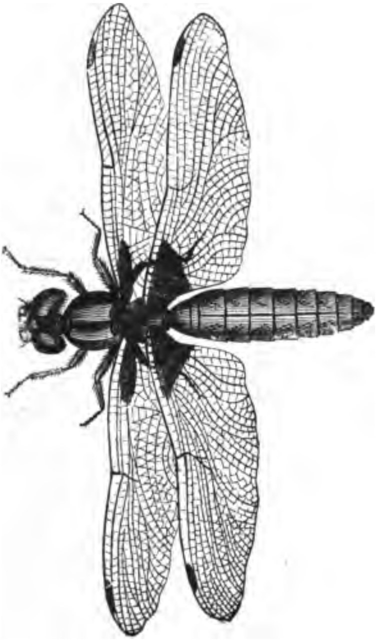
The larvæ and pupæ of the *Orthoptera* bear a very strong resemblance to the perfect insects, and outwardly seem only to differ with regard to the wings, which in the larva are entirely wanting, and in the pupa are only partly developed. Both larva and pupa are equally active with the perfect insect. The food is the same both in the preliminary and perfect stages.

The *Orthoptera* include the crickets, grasshoppers, and cockroaches of this country, and the leaf and walking-stick insects, etc., of abroad.

Next in order come the *Neuróptera*, or 'nerve-winged' insects, such as the dragon-flies, lace-wings, May-flies, etc. They are possessed of four transparent wings, equal, or nearly so, in size, and traversed by an furnishedintricatenet work of nervures, which are closely spread over the whole surface. The mouth is with jaws.

The larvæ of the *Neuroptera* are very different in appearance from the perfect insects, and are provided with the usual six jointed legs, each of which is terminated by a pair of strong claws. The pupæ often closely resemble the larvæ, and are sometimes active, and sometimes quiescent.

Next come the *Trichóptera*, or 'hairy-winged' insects, a small order comprising the well-known caddis-flies. These were formerly included among the *Neuroptera*, but were separated on account of the hairiness of the wings, and the mode of life of the larvæ, which reside in cases which they build of little twigs, empty shells, stones, straws, etc. When at rest, the lower pair of wings are folded beneath the upper, which are placed tent-wise longitudinally over the body.



Libellula depressa.

Next follows the large and important order of the *Hymenóptera*, or 'membranous-winged' insects, comprising the bees, wasps, ants, ichneumons, etc. They are distinguished by possessing four transparent wings, in which the nervures are more widely distributed than is the case in the *Neuróptera*. During flight, they are firmly fastened together by a row of small hooks, which are placed upon the inner margin of the hind wings, and which fit into a fold in the lower margin of the upper pair. In many of these insects it is almost impossible to detect the second pair of wings without close examination, the two pairs being so closely united that they appear like one.

The small hooks which unite the wings vary considerably both in size and form in different branches of the order, and are very well worth a careful examination beneath a tolerably high power of the microscope. They are so distinct in structure that a single hook will serve to identify the group to which the insect belongs.

Among the *Hymenoptera* are included the only insects which possess stings, properly so-called, such as the bees, wasps, and hornets. Only the female insects possess these weapons, the males being perfectly harmless.

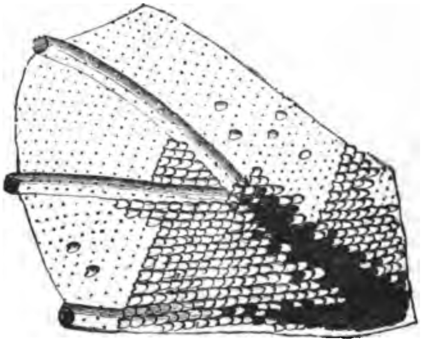
The sting is in reality nothing more than a modification of the ovipositor, provided with a poison-sac and duct. The poisonous fluid is secreted by two long and slight hair-like glands, one upon each side of the body, which lead into the poison-sac.

The larvæ of the *Hymenoptera* are usually soft, grub-like objects, entirely without the means of locomotion, and often requiring to be fed and tended by the adult insects. This is the case in the bees, wasps, hornets, and ants. The eggs of the various ichneumon-flies, however, are deposited within the bodies of living caterpillars, the young larvæ feeding upon the flesh of the unfortunate victim, and carefully avoiding the vital organs, until the time approaches for their involuntary host to change to the pupal condition. The 'stung' caterpillar then dies, and the parasites issue from its carcase sometimes in their pupal, and sometimes in their perfect state, having undergone their preliminary stages in the body of their victim. The larvæ of the saw-flies differ from those of the rest of the *Hymenoptera* in being provided with legs. Of course, in these cases, the grubs are able to take care of themselves.

The *Lepidoptera*, more commonly known as butterflies and moths, come next upon the list, and are, perhaps, the most widely known of all orders of insects. The name, *Lepidoptera*, is a very appropriate one, being derived from two Greek words signifying respectively a scale and a wing—'scale-winged' insects. Everybody is aware that if a butterfly or moth is roughly handled, a sort of coloured mealy substance is left upon the fingers, and the wing becomes transparent, like that of a fly, wherever it has been touched. If a small quantity of this mealy dust is placed beneath the microscope, it will be seen to consist of innumerable scales, of various sizes and shapes, glowing with all the colours of the rainbow and many more besides, and sculptured and chiselled in a most wonderful manner. It is to these scales that the *Lepidoptera* owe the colours and marking of their wings; for if they are rubbed off, the wings are seen to be formed of a simple, transparent membrane, as are those of a bee or gnat.

These scales are arranged upon the wings in rows, as may be seen in the following illustration, which represents a portion of the wing of a moth under a high power of the microscope. The overlapping rows can be plainly seen, while in the part from which the scales have been removed a row of small dots denotes the position of their former roots.

There is a curious point about the development of these scales when the insect emerges from the pupal state. The wings are then folded and crumpled, and quite soft, not yet having been hardened by the air. The scales, however, are of their full size, and the rows are merely packed much more closely beneath each other than is the case when the wing is fully developed. As the wings are gradually spread to their full extent, the rows of scales are pushed forward from beneath each other, until the development is complete.



Portion of a Wing of a Moth.

There is one family of moths in which the wings are almost entirely without scales, and in which the insects are consequently known as Clear-wings.

Most of these moths bear a wonderful resemblance to certain *Hymenoptera*, such as the hornet, the gnat the wasp, and so on, and are usually named after them. The likeness is often so great that even experienced entomologists sometimes find considerable difficulty in distinguishing between the two insects. Many a collector has been badly stung through mistaking the true hornet for the impostor, while at the same time he has allowed numbers of true clearwings to escape for fear of the stings which he supposed them to possess.

Another of the great distinctions in the *Lepidoptera* is found in the structure of the mouth.

The mandibles, or larger jaws, which are so strongly developed in the *Coleoptera* and other orders, in the butterflies and moths are almost rudimentary, and are not used by the insect in supplying itself with food. The *maxillæ*, or lesser jaws, however, are developed to a wonderful degree, and form a complete tube, which can be coiled away, when not in use, beneath the head. This tube, or *proboscis* as it is properly termed, can be separated into two portions, each answering to one of the maxillæ of which it is a development. The two parts are held together so as to form a tube, by a series of minute hooks, which, in spite of their small size, are of considerable strength.

Through this proboscis, liquid nourishment, which is the only form of food taken by the perfect *Lepidoptera*, is sucked up into the mouth.

The pupa is incapable of motion, and is enclosed in a semi-transparent horny case.

The *Lepidoptera* are usually divided into two great classes, namely, the *Rhopalocera*, or butterflies, and the *Heterocera*, or moths. The insects of the former group are distinguished from those of the latter by their knobbed antennæ, and by the abdomen being considerably narrowed at its junction with the thorax. The wings, too, are never folded, but project flat from the body.

Next in order come the *Homoptera*, or 'similar-winged' insects, so called from both the upper and under wings being constructed after the same fashion. All four wings are of a membranous character, and are all used in flight. The mouth is provided with a long, slender proboscis, not capable of being coiled like that of a butterfly or moth, by which the juices of plants are extracted to serve as food for the insects. There are never more than three joints in the *tarsus*, or foot.

The larvæ and pupæ closely resemble the perfect insects, only differing from them in the development of the wings. Aphides, and the insects which form the well-known 'cuckoo-spit,' and are commonly termed 'frog-hoppers,' besides many others, are included in the *Homoptera.*

The *Heteroptera*, or 'different-winged' insects, are the next on the list. The wings of those species which possess them in a perfectly developed state are horny near the base, the rest being membranous and transparent. The body is flattened, and the head is furnished with a proboscis, which starts from the front of the under surface of the head, and not from the back as is the case in the *Homoptera.* The larvæ and pupæ are similar to those of that order.

Many of the *Heteroptera* frequent the water, and others the land; the water-gnats, water-boatmen, water-scorpions, etc., among the former, and the 'bishop's mitres' and the too well-known bed-bug among the latter, being comprised in the order.

The *Homoptera* and *Heteroptera* are generally included under the one head of *Hemiptera*, or 'half-winged' insects, *i.e.*, those which have half of the wings membranous. The two groups are then known as *Hemiptera-homoptera* and *Hemiptera-heteroptera.*

A very large group of insects is the *Diptera*, or 'two-winged' flies, so called because the first pair of wings only is developed, the second being modified into a couple of small knobs, known as balancers, or, scientifically, *halteres.*

In such insects the *halteres* seem necessary to flight, for, should they be removed, the insect is unable to direct its course. At the base of the wings is generally found a pair of wing-like objects, or *alulets*, which are merely modifications of part of the upper pair.

The mouths of the *Diptera* are adapted for suction, and are often modified into weapons of offence, as is the case in the common gnat.

The preliminary stages of the growth vary considerably in different species, the larvæ and pupæ, however, generally being very distinct from each other.

The last order of insects is the *Aphaniptera*, or 'hidden-winged' insects, the wings being only rudimentary, and represented by four very minute scales upon the thorax. The insects of this order are popularly known as fleas.

The larvæ are small white grubs, and are entirely without legs, working their way along by means of a row of stiff bristles with which the margin of each segment is furnished.

It will thus be seen that the Insects are divided into eleven orders, of which the *Coleoptera*, *Hymenoptera*, *Hemiptera*, and *Diptera* are by far the most important. Of the first-named alone at least sixty-thousand species are known to exist, while large numbers, we may feel certain, are as yet undiscovered.

No. IV.—THE COLEOPTERA, OR BEETLES.

PART I.

BESIDES their primary division into Orders, insects are further subdivided into classes of lesser importance, which are severally known as groups, or divisions, families, and genera. These terms I will now endeavour to explain.

A group comprehends such insects in any one order as agree in some essential point of structure, such as the formation of the mouth, or the antennæ, although their general form and habits may be widely dissimilar. Thus the members of the *Clavicornia*, or 'club-horned' insects, one of the chief divisions of the coleoptera, are included in a single group on account of the structure of their antennæ, which are expanded into a rounded club, or knob, at the tip. Yet, in other points, they vary to a very great extent, and, were it not for this distinguishing characteristic, would never be recognised as belonging to the same group of insects.

Families may be described as divisions of smaller size, many of them being often included in a group. They are composed of insects agreeing in their chief characteristics, and generally exhibiting less variety of form than is the case in a group.

A *genus* is a smaller family, and sometimes consists of a single insect alone, in other cases of many hundreds. In a genus, as a rule, there is comparatively little diversity of form.

As regards the nomenclature of insects, every known species possesses two scientific names, just as is the case throughout the zoological and botanical kingdoms. The first is that of the genus, which is borne alike by all the insects included in it; the second that of the individual species. Besides these, in a full description, the names of the order, group, and family would be introduced. So, we might describe the well-known Purple Ground Beetle as follows—order, *Coleoptera*; group, *Geodephaga*; family, *Carabidæ*; genus, *Carabus*; species, *violaceus*; while we should ordinarily speak of it merely as *Carabus violaceus.* Other members of the genus would be known as *Carabus granulatus*, *C. auratus*, and so on. The Red Admiral Butterfly, too, we should describe as—order, *Lepidoptera;* group, *Rhopalocera* (or Butterflies); family, *Vanessidæ;* genus, *Pyrameis;* species, *Atalanta;* speaking of it merely as *Pyrameis Atalanta.*

The *Coleoptera*, or beetles, are generally considered as being divided into twelve *groups*, each of which will be mentioned in turn.

The first, and one of the most important, is that of the *Geodephaga*, a word signifying 'earth-devourers,' *i.e.*, predacious beetles living upon the land, as opposed to those inhabiting the water.

In this group are included many most interesting insects, some of which play no inconsiderable part in maintaining the balance of Nature.

For example, who would think that many of the enormous pine forests of the Continent, whence we obtain so large a share of our timber, owe their very existence to the labours of a single Geodephagous beetle? Yet, such is the fact, and, were it not for this insect, which is known as *Calosoma sycophanta*, hardly a pine-tree would now be left standing.

The beetle is a most gorgeous object, reminding one of tropical insects in the brilliancy of its colours. The thorax is of a deep violet black, with the borders brighter, as is the case in the Purple Ground Beetle, while the elytra, or wing-cases, are of a brilliant gold-green shot with purple, the hues seeming to change with every movement of the insect.

In our own country this beetle is extremely rare, and the few specimens which have been met with have probably been accidentally introduced from abroad. Upon the Continent, however, it is plentiful enough, fortunately for mankind.

Its services, both as a larva and a perfect insect, consist in devouring the destructive caterpillars of various moths, more especially those of the Processionary *(Cnethocampa processionea)* and the Gipsy *(Liparis dispar).* But more destructive even than these, the grub of the Pine Saw-fly is more especially attacked by the *Calosoma*, which keeps down its numbers to a most wonderful extent. But for this, a single year would witness the destruction of large tracts of forest, for the pine-trees, once stripped of their leaves, cannot, like other trees, throw out fresh foliage, but speedily die.

So useful is the *Calosoma*, that it has even been introduced into infested districts where it did not previously occur, and with the very best results.

The well-known Tiger Beetles *(Cicindelidæ)* are included among the *Geodephaga*, and form the first family of the group. They may be seen on any sunny day throughout the summer, and are especially common on sandy banks, heaths, etc., dashing about in the hot sun like living gems, and taking to flight with the ease and rapidity of a blue-bottle. Both in the larval and perfect states these beetles, four species of which inhabit England, are extremely voracious, preying chiefly upon the smaller insects.

There is an extraordinary beetle in this group which has the singular property of possessing a mimic artillery with which to repel its foes. This is the Bombardier *(Brachinus crepitans)*, which secretes a highly volatile fluid, a small quantity of which it can expel at will. When pursued by any of its numerous foes, the beetle ejects a small portion of this fluid, which passes into vapour as soon as it comes in contact with the air, causing at the same time a slight explosion, and effectually alarming its enemy. This discharge it can repeat twenty or thirty times in succession, the cloud of blue smoke bearing a remarkable resemblance to the fire of small artillery.

Should any of this volatile fluid come into contact with the human skin it causes a slight burning sensation, and leaves a perceptible stain behind it. The beetle is chiefly found upon the banks of rivers, where fifteen or twenty specimens may sometimes be found beneath a single stone.

The greater number of the beetles of this group seek their prey only by night, retiring during the day to some place of concealment where they may be sheltered from their numerous enemies. They may often be found hiding beneath stones, dead leaves, etc., and in similar places.

The next division is that of the *Hydradephaga*, or Water-devourers—*i.e.*, predacious beetles which live chiefly beneath the surface of the water. Their structure is worthy of a detailed examination.

First, as regards their swimming capabilities. All these beetles swim by means of the hind-legs, which are very long, flattened, and closely fringed with long stiff bristles. These legs perform the functions of oars, and are formed in such a manner that, as they are brought forward for a second stroke, they turn sideways and present their edge to the water, thus cleaving through it, and offering no resistance. In fact, they are 'feathered,' just as are the oars of a boat, only in the case of the insect the operation is entirely mechanical.

Although of the greatest service in the water, enabling their owner to travel at a considerable speed, these legs are of very little use upon dry land, and, indeed, seem rather to incommode the insect than otherwise. It proceeds by the most awkward and ungraceful waddle that can possibly be imagined, feeling, no doubt, much as does a skater when his rapid and easy evolutions are suddenly stopped by the breaking of a skate, and he is obliged to walk back upon the ice.

These water-beetles are possessed of broad and powerful wings, which enable them to pass from pond to pond at will. They usually perform their aerial journeys by night, and are accustomed, when they wish to return to their native element, to hover over a pond or stream, and, suddenly closing their wings, allow themselves to drop into the water, often from a considerable height. Sometimes, mistaking the glass roof of a greenhouse for a pond, they fall upon the panes with a considerable shock, doubtless much to their astonishment.

Upon examining one of these insects it will be seen that, when the wings are packed away, a considerable space is left between the elytra and the body, the object of which may not at first be apparent. Its real use will shortly be seen.

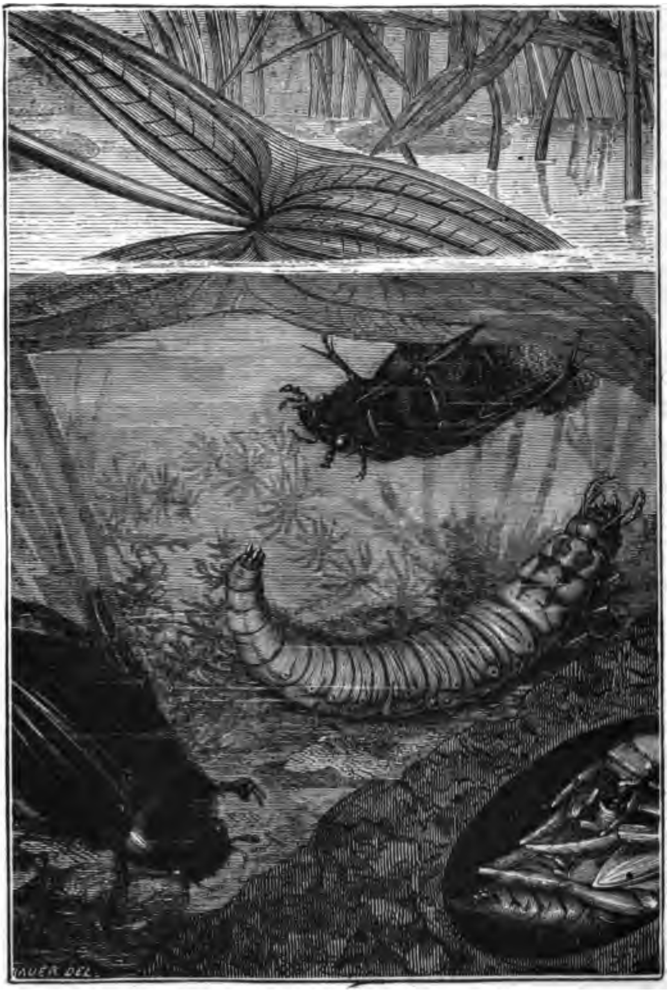
Although the *Hydradephaga* pass a considerable portion of their existence beneath the water, they are not provided with gills, as are the fish, but are forced to breathe atmospheric air, just as are all other insects. For the purpose of renewing their supply, these insects rise to the surface of the water every few minutes.

As, however, a single respiration would suffice for so short a time that the insects would be able to spend a few seconds only beneath the water, they are provided with the means of carrying down a supply of air with them, the space between the elytra and the body serving as a reservoir. Into this, the spiracles, or breathing holes open, and a water-beetle can thus remain submerged for a considerable space of time.

When the supply of air needs renewal, the insect floats head downwards at the surface of the water, the tips of the elytra just projecting, and the long hind-legs being spread out on either side like oars. The exhausted air is then expelled with a curious popping sound, and a fresh supply taken in. On a fine day, the water insects may be seen floating in numbers on the surface of any pond, the least footstep, however, being sufficient to alarm them and cause them to retreat to the depths below.

The shape of these beetles is admirably adapted to their subaquatic life, the form bearing a close resemblance to that of the fish, while the smooth and polished surface of the body affords but little resistance to the water.

In some of the beetles of this class, and notably in the Great Water-beetle *(Dyticus marginalis)*, the tarsi of the front legs of the male are modified in a very peculiar manner, being dilated into a broad pad. Upon examination with a magnifying-glass, this pad is seen to be furnished with a number of suckers, some thirty or forty in all, of various sizes, some of which are set upon stalks, while others proceed from the pad itself. As the air can be exhausted from beneath each of these suckers, the clinging power of the insect is very great, it being able to ascend the perpendicular sides of a glass jar without any apparent trouble. This structure is found in the male alone, the tarsi of the female being perfectly simple.



Waterbeetles in their larval, pupal, and perfect states.

The sexes of this insect can be easily distinguished by a single glance at the elytra, which in the female are deeply grooved for about two-thirds of their length, those of her partner being smooth. The insect is plentiful in ponds throughout the kingdom. A very similar insect is the Lesser Water-beetle *(Acilius sulcatus)*.

The name of the beetle is a singularly appropriate one, the word *Dyticus*, from the Greek, signifying a diver, and being applied to the insect on account of its swimming capabilities, and the term *marginalis* referring to the yellow border of the thorax and elytra. Several species of the genus inhabit England, of which the above-named is by far the most abundant.

The larvæ of the various water-beetles are fully as predacious as the perfect insects. They are long grub-like creatures, provided with six legs, and an enormous pair of horny jaws, to aid in the capture and detention of the prey. These jaws are perforated throughout their length, somewhat after the manner of the poison-fangs of a serpent, and through these channels the juices of the prey are sucked into the mouth.

These larvæ proceed in the water in a curious sinuous manner, approaching their prey from beneath, and seizing it before their presence is detected.

The change to the pupal condition does not take place in the water, the full-grown larva leaving the pond, climbing the bank, and burying itself in the damp mud, forming for itself a round chamber or cocoon therein.

Then there are the curious little Whirligigs, or Whirlwigs *(Gyrinus natator)*, which may be seen dashing about in numbers on the surface of any pond, their polished black bodies gleaming in the sunlight. The legs are formed in a very curious manner, the second and third pairs being so short as to be scarcely visible.

It must not be thought that all the beetles inhabiting the water are necessarily *Hydradephaga*, for such is not the case. A large number are included in the *Palpicornia*, or *Hydrophilidæ*, which are, as a rule, not predacious, or only so in a very slight degree. The legs are formed more for crawling than swimming, the insects spending their existence among the weeds and mud of the ponds instead of leading the active life of the true water-beetles. All these beetles may be known by the palpi, which are as long as, or even longer than the antennæ, which never possess more than nine joints.

One of the best known, although not the most abundant of these, is the Black Water-beetle *(Hydrophilus piceus)*, which, with the exception of the Stag Beetle, is the largest of our British *Coleoptera*, averaging about an inch and two-thirds in total length. This beetle will be seen represented in all its stages in the illustration on the opposite page.

The insect is remarkable for the manner in which the eggs are laid, a silken cocoón being formed by the female, and fastened to the stem of some water-plant. Within this cocoon the eggs are deposited, being thus sheltered from harm until the young larvæ emerge, an event which takes place in about five or six weeks.

The *Palpicornia* are not all frequenters of the water, many of them, such as the various Cercyons, depending for existence upon the droppings of animals, in which they spend the greater portion of their life. Rubbish heaps, hot-beds, etc., mostly swarm with them, too, looking like small red-and-black beads when their habitation is disturbed.

No. V.—THE COLEOPTERA, OR BEETLES.

Part II.

THE *Brachelytra*, or *Staphylinidæ*, popularly known as the Cocktail, or Rove Beetles, form the next of the principal divisions of the Coleoptera.

Their chief distinguishing characteristic is found in the elytra, which are wonderfully small, seldom covering more than two segments of the abdomen, the remainder of which is left free. In some cases, even, the elytra are shorter than the thorax.

In spite of the small size of the elytra, however, the wings are very large, and are folded and packed away beneath their cases in the most wonderful manner. This operation is chiefly performed by the tip of the abdomen, which is bent over the back for that purpose; hence, the name of Cocktails.

Most of the *Brachelytra* are long, narrow insects—some, in fact, being almost thread-like. They may be found in all sorts of decaying animal and vegetable matter, carrion, manure-heaps, cattle-droppings, etc., always containing them in great numbers. To the labours of these beetles, and some others, in fact, we are indebted for the prevention of numberless fevers and agues, for no sooner does garbage of any kind show signs of decomposition than it is attacked by the insects, and before long completely devoured.

In size, these insects vary very greatly. The well-known Devil's Coach-Horse (*Ocypus olens*), for example, attains the length of an inch and a quarter, while some of the smaller British species are of microscopical dimensions, never exceeding one forty-eighth of an inch in length.

This Coach-horse beetle is common enough almost everywhere, hiding under stones, rubbish-heaps, etc., by day, and sallying forth at night in search of prey. Its dull black colour, and threatening aspect, give it a most repulsive appearance, and few except entomologists would care to meddle with so unpleasant-looking an insect.

In reality, it can do very little harm, although its jaws are able to inflict a rather powerful nip. It possesses, however, the power of exuding a fluid of the most unpleasant and penetrating odour, which hangs about the fingers for days, and cannot be removed without considerable trouble. Most of the rove beetles make use of this unpleasant mode of defence, the fluid being secreted in two glands at the extreme tip of the abdomen.

The *Ocypus* is remarkable for the size of its eggs, which are of wonderful size in comparison with the dimensions of the insect, being no less than one-tenth of an inch in length. The larvæ are not unlike the parent insect, with the exception of the absence of wings.

A closely allied species, *Leistotrophus nebulosus*, is perhaps one of the most fierce and courageous of the group. Although considerably less in size than the *Ocypus*, it can do infinitely more damage, and if carelessly held will cause its jaws to meet in the flesh of the captor. This insect is rather a handsome one, being brown, mottled with grey and black.

Some of the smaller *Staphylinidæ* are only too well known as possessing a remarkable talent of flying into the eye, where they cause considerable irritation before they can be ejected. The little black 'flies,' which are so troublesome on summer evenings, are almost always *Brachelytra*, as can be seen by waving a sheet of gummed paper in the air, when the beetles will adhere to it.

NEXT in order we have the *Clavicornes*. These, as before mentioned, may be known by the structure of the antennæ, which are expanded at the tips into a kind of club.

The beetles of this group are far more variable in size and form than are the *Brachelytra*. Some of them strongly resemble the insects of the latter group, the elytra being very short, and leaving the greater part of the abdomen unprotected. Many of these insects, all small species, are found in the nests of various ants, in company with some of the *Staphylinidæ*, where they are as jealously protected by the insects as are their own larvæ and pupæ, being carefully tended, and carried away into the interior of the nest at the slightest sign of danger. The object of their presence is not yet known.

Perhaps the most interesting beetles of this group are those popularly known as Burying, or Carrion Beetles, and scientifically as *Necrophori*.

Several species of these beetles inhabit this country, and are tolerably common, although seldom seen except by those who know how to look for them.

As their popular title infers, these beetles are chiefly to be found in carrion, and may be obtained in plenty from the carcase of any dead animal which is found lying in the fields. But their habits are very different from those of the *Staphylinidæ* and other beetles which are found in their company.

As soon as they detect the odour of decaying flesh, the burying beetles wing their way to the spot, not so much for the purpose of finding food for themselves as for providing it for their future offspring.

Now, if the eggs were deposited in the carcase as it lay upon the ground, decomposition would be complete in a few days, and the newly-hatched grubs would thus be left without food. In order to obviate this possibility, the carcase is completely buried by the beetles, which shovel away the earth from beneath it by means of their broad and powerful heads. After digging for some little time, throwing out the earth as they proceed, they emerge from beneath the body, and rest for an hour or so. What follows can best be told in the words of the late Mr. E. Newman, in his famous 'Letters of Rusticus.'

'The male beetle then dives again into the grave, and pulls the bird down by the feathers for half an hour. Its own weight appears to sink it but very little. The earth then begins heaving and rising all round, as though under the influence of a little earthquake; the feathers of the bird are again pulled, and again the bird descends. At last, after two or three hours more labour, the beetle comes up, again gets on the bird, and again takes its survey, and then drops down as though dead, or fallen suddenly fast asleep. When sufficiently rested, he rouses himself, treads the bird firmly into its grave, pulls it by the feathers this way and that way, and having settled it to his mind, begins to shovel in the earth. This is done in a very short time, by means of his broad head. He goes behind the rampart of earth, and pushes it into the grave with amazing strength and dexterity, the head being bent directly downwards at first, and then the nose elevated with a kind of jerk, which sends the earth forwards. After the grave is thus filled up, the earth is trodden in, and undergoes a keen scrutiny, all the bird being completely hidden; the beetle then makes a hole in the still loose earth, and having buried the bird and his own bride, next buries himself.

The female lays her eggs in the carcase of the bird, in number proportioned to its size; and after this operation is over, and the pair have eaten as much of the savoury viand as they please, they make their way out, and fly away in quest of further adventures.'

It will thus be seen that the carcase, being buried in the ground, is preserved in the best condition for the food of the future larvæ, for the moisture of the earth prevents it from drying up, while it is protected from the sun and rain which would cause it to decompose with undue rapidity.

Burying Beetles and dead Mouse.

The burying beetles are handsome insects, the ground colour being black, with two broad bands of orange crossing the elytra; one very common species, however, is altogether black. In the accompanying illustration some of these beetles will be seen engaged in interring a dead mouse.

The burying beetles are usually assisted in their task by some of the various Histers and *Silphidæ*, of both of which there are many species. The former are rather small, highly-polished insects, which feign death on being touched, rolling up the legs beneath the body, and remaining perfectly still until they imagine the danger to be past. They are chiefly black in colour, although some of the species are spotted with red. The Silphas are flat beetles, with the head almost entirely hidden away beneath the thorax. These latter insects are also common in old bones, and also in the carcases of 'vermin' suspended on the 'keepers' trees' in coverts.

To the *Clavicornes* also belong the *Trichopterygidæ*—beetles so small that a powerful microscope is necessary in order to distinguish them from one another. These tiny insects are common in rubbish heaps, looking like living black specks as they move about.

Another interesting family in this group is that of the *Dermestidæ*, the commonest species of which, *Dermestes lardarius*, is popularly known as the Bacon Beetle.

These insects, like the burying beetles, are carrion feeders, and are abundant in the carcases hung upon the 'keepers' trees' before-mentioned, preferring, however, the dried skins to the decaying flesh. In museums they are terribly destructive, detecting any skin which has not been properly prepared, and reducing it to fragments in a very short space of time.

The Pill Beetles *(Byrrhidæ)* also belong to this group. The beetles of this family possess a wonderful faculty of simulating death when alarmed, the legs and antennæ fitting closely into grooves upon the under surface of the body, and the creature resembling a small dusty stone far more than an insect.

While thus feigning death, the pill beetles will allow themselves to be picked up and handled without evincing the slightest sign that they are living objects,

Cockchafer (Melolontha Vulgaris).

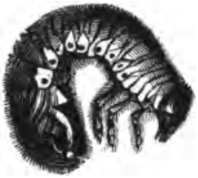
and not until the danger may be supposed to have finally disappeared do they unroll their limbs and continue their journey.

Some of the Clavicornes are inhabitants of the water, although in a different way to either the true water-beetles, or the *Hydrophilidæ.* They do not swim actively through the water in pursuit of prey like the former, or spend their existence in crawling upon the aquatic weeds, etc., as do the latter, but are chiefly found clinging to the under surfaces of stones lying in the beds of swiftly running streams.

NEXT we come to the Lamellicorns, or 'leaf-horned' beetles. These derive their title from the structure of the antennæ, the club of which is composed of three or more plates attached to each other at one end, and usually moveable like the rays of a fan. These beetles are popularly known as Chafers.

The most abundant and best known of these is the common Cockchafer *(Melolontha vulgaris),* which is so terribly destructive to the farmer and agriculturist.

The egg of this insect is laid beneath the ground, and the grub, which shortly emerges, feeds upon the roots of the grass and other crops, often doing incalculable damage. In some places, even, the turf may be rolled up by the hands, the roots of the grass having been completely destroyed by the grubs.



Larva of Cockchafer.

The perfect insect is fully as destructive, feeding upon the foliage of trees, and sometimes entirely stripping them of their leaves. The larva and pupa, as well as the perfect insect, are shown in the accompanying illustrations.

Pupa of Cockchafer.

The well-known Dor, or Watchman Beetles *(Geotrupes)*, are also included in this group. These form the direct opposite of the preceding beetle, being absolutely beneficial to mankind by removing the dung of animals beneath the ground in somewhat the same manner as carrion is buried by the *Necrophori.*

The dor beetle, when about to deposit her eggs, selects a patch of cow-dung, and burrowing her way into it, digs a tunnel some ten or twelve inches in depth into the earth beneath, by means of her powerful front legs and head. Ascending again to the surface, she carries down a portion of the dung to the bottom of her tunnel, deposits an egg in the midst, and sets to work at a second tunnel, and so on until she has laid the whole of her eggs. The grubs, when hatched, feed upon the food thus stored up for them until they are able to ascend to the surface of the ground and cater for themselves.

Some of these dung-loving beetles are constructed in a manner which strongly reminds one of the curious forms found in the tropics. Especially is this the case with the insect scientifically known as *Typhæus vulgaris*, but possessing no popular name. In this species the thorax is developed into three horns, or teeth, two of which project on either side, enclosing the head between them, while the third slants obliquely upwards midway between them. The male, only, possesses these singular appendages, which, in the female, are merely represented by small pointed knobs.

The strength of all these burrowing insects is very great, that of the fore-limbs, upon which falls all the burden of the work, being especially remarkable. This can be easily proved by attempting to confine one of these insects in the closed hand, when the strength of the digging legs will be found as much disproportioned to the size of their owner, as that of Hercules would be in the arms of an ordinary human being.

Yet, when we consider the work done by these insects, we marvel, not at the power of their limbs, but at the fact that creatures so tiny, strong though they may be, should be able to perform such feats. For an ordinary dor-beetle to burrow some twelve inches into the ground is much the same as if a man of ordinary stature were to dig, aided by no other tools than those with which nature has provided him, a tunnel of seventy-two feet in depth, and exceeding in diameter the size of his body.

These beetles are most abundant in the spring and autumn, when they may be seen circling about at dusk, searching for a favourable spot in which to deposit their eggs.

The well-known Stag Beetle *(Lucanus cervus)* is also a member of this group. This is a very unequally distributed insect, in many places being exceedingly common, while in others it is never seen.

There is a considerable difference between the sexes, the male being a much larger insect than his mate, and possessing long and toothed jaws, those of the female being short and sickle-shaped. It is not the case, however, as might be thought, that the bite of the male is the more severe, for his jaws can do little or no damage, while the sharp mandibles of the female can inflict a tolerably severe bite, sometimes even meeting in the flesh.

The jaws of the stag beetle, and more particularly of the female, are capable of considerable exertions. I remember a case in which a female specimen of this insect, one of my own capture, was placed inside a strong willow-chip box and forgotten. Some days afterwards, upon looking at the box, the beetle was found to have worked her way partly through the side, having gnawed a hole large enough for her head and her fore-legs to pass through. When once in this position, however, she was unable to move either backwards or forwards, and, had she not been released, must have remained fixed until death set her free.

The stag beetle is one of the wood-feeding insects, the larva dwelling in the trunks of trees. Remaining, as it does, in this state for several years, during the whole of which time it is burrowing in the wood, it can be easily imagined that it causes no little havoc, and if a tree is attacked by several of these larvæ its doom is sealed.

When full-fed, the larva leaves the wood and burrows into the earth, where it constructs for itself a strong cocoon in which to undergo its change to the pupal condition. The perfect insect appears in reality about the middle of winter, although it is seldom seen at large until June; for pupæ, opened in January, have been found to contain fully-developed insects. This is also the case with many other beetles, which, undergoing their final change during the winter, do not make their appearance in the world until considerably later in the year.

The size of the stag beetle is exceedingly variable, a well-developed male sometimes attaining the length of three inches, while other specimens are barely one-half of that size.

No. VI.—THE COLEOPTERA, OR BEETLES.

Part III.

THE Sternoxi comprise the long, narrow beetles, popularly known as 'Skip-jacks,' a title derived from their curious method of regaining their feet if they should happen to fall upside down upon a level surface. The legs being very short in proportion to the size of the beetle, the insect is unable to regain its foothold in the ordinary manner, but does so in a very remarkable way.

Lying perfectly still for a second or two, as though to summon up all its energies, a sudden 'click' is heard, and the beetle flies for two or three inches into the air, turning half round as it falls, and usually alighting upon its feet. Should it be unsuccessful, as sometimes happens, a second attempt is made, and so on until success crowns its efforts.

A glance at the structure of the thorax will give us a clue to this curious habit.

The *prosternum*, or under side of the prothorax, is produced into a kind of spike (scientifically termed the *mucro*, or dagger), which, when the insect is at rest, fits into a groove between the second pair of legs. When the insect falls upon its back, and wishes to regain its feet, it arches its body into the air in such a manner that it rests only upon the head and the tip of the elytra. While making this movement, the mucro is mechanically drawn from its sheath. With a sudden jerk the position is reversed, and the mucro flies back into its place, forcing the base of the elytra sharply against the ground, and so driving the insect into the air. The word 'Sternoxi' (*i.e.*, sharp-breasted) refers to this structure.

Whilst the beetle is in the act of leaping, the antennæ lie in grooves on the under side of the head, and are so protected from the risk of injury by the fall. In one family, the *Buprestidæ*, this power of leaping is not present.

The beetles of this group are only too abundant, their larvæ being the well-known 'wire-worms,' which are so terrible a pest to the agriculturist. They are long, thin creatures, generally of a yellowish-brown colour, and so tough-skinned that it is almost impossible to damage them, a stamp from a heavy boot merely forcing them into the soil, without causing them the slightest injury.

These wire-worms confine their ravages to the roots of various vegetables, but, being hidden from sight, cause infinitely more damage than the creatures which feed upon the more exposed portions of the crops. As far as is at present known, no plan seems to succeed in destroying them, and were it not for their natural enemies, viz., the mole, and various birds, the wire-worms would render agriculture an almost total impossibility.

The perfect insects may be found in great numbers during the early part of summer, resting upon leaves and flowers, or flying slowly and clumsily through the air.

The next of the principal groups of beetles consists of the MALACODERMI, or 'soft-skinned' beetles. These comprise the well-known 'Soldiers and Sailors,' the Glow-worm, and many others

The glow-worm (*Lampyris noctiluca*) deserves more than a mere passing mention.

This insect is well known in almost every part of the country, the pale greenish light emitted by the insect being familiar to even the most unobservant. If the female glow-worm be examined, it will scarcely be taken for one of the beetles, so different is it from those with which we are ordinarily acquainted, possessing neither wings nor elytra, and reminding one far more of a grub than a perfect insect.

Ninety-nine out of every hundred glow-worms met with by the casual observer, however, are females, the males being seldom or never seen except by practical entomologists. The two sexes are strangely dissimilar in appearance, and few would imagine the handsome winged male and the grub-like female to belong to the same species.

Both are luminous, the female in a far greater degree than the male, whose lamp is dim and comparatively insignificant. The light proceeds from the under surface of the three terminal segments of the abdomen. It varies considerably in intensity, being under the control of the insect, which can increase or diminish it at will.

No observer has as yet satisfactorily determined either the cause or the object of this curious property. As far as the former is concerned, very little is known, although many theories have been advanced upon the subject.

As regards the latter, the usual notion is that the light is intended to act as a guide to the male. At first sight this seems plausible enough, but there are several facts which militate against the idea. In the first place, it seems strange that certain night-flying insects should be gifted in such a manner, while others are passed over. Again, if the light of the female be intended to attract her mate, of what use is the luminosity of the male?

Moreover, the larvæ and pupæ are also luminous, as are even the eggs in a slight degree. In these preliminary stages of development, of course, the attraction theory cannot hold good, and we are again at a loss to account for the true object of the light.

The glow-worm is one of the many unrecognised benefactors of the human race, the larva preying largely upon snails, which are destroyed by these creatures in great numbers. At the extremity of the body of the larva is seen a brush-like structure, which is utilized for the double purpose of aiding locomotion, and for cleansing the body from the slime of the snails which have fallen victims to their insatiable foe.

These larvæ may be commonly found both in the autumn and again in early spring, closely resembling the perfect female in general appearance. Towards the middle of May they change to the pupal condition, appearing in the perfect state in the course of two or three weeks.

The TEREDILIA, or Borers, include the little beetles, popularly known as Death-watches, concerning which so many superstitions are still rife amongst the uneducated classes. One of the most abundant of these is the little insect bearing the scientific title of ***Anobium striatum***, which is usually the destructive agent in 'worm-eaten' furniture. The peculiar 'ticking' sound, generally considered as the premonition of approaching death to some inmate of the house, is caused by the insect striking its head against the woodwork of the room, as a call to its mate.

The title of HETEROMERA, a word signifying 'unequal jointed,' has been applied to the succeeding group of beetles on account of the structure of the *tarsi*, those of the first and second pairs of legs possessing the full number of five joints, while only four are visible in those of the hinder limbs, the missing joint being merged into the basal one, and so escaping observation. There are also various minor characteristics which it is needless to mention in a series of elementary papers such as the present.

Although the *Heteromera* include a considerable number of insects, the greater proportion are only known to practical entomologists, who have made the coleop tera their especial study. One or two beetles, however, of those included in the group are familiar to most of those who take even a superficial interest in natural history.

One of these is the common Oil Beetle (*Melöe proscarabæus*), which is plentiful enough in the early spring, and may be seen slowly crawling on the hedgebanks bordering the roadsides. The earlier stages of the oil beetle are very remarkable.

The eggs are laid by the parent beetle in the ground, the young grubs, when newly hatched, being very minute, and furnished with six strangely long legs. Immediately after leaving the eggs, these larvæ find their way to the surface of the ground, and make for the nearest flowers, ascending the stems, and concealing themselves among the blossoms.

Before very long a bee comes in search of honey, and the young grubs leave their retreats, and transfer themselves to the body of the visitor, who unconsciously carries them off to her nest.

Several hundreds of these creatures will sometimes attach themselves to a single humble bee, covering the whole of its body and limbs, and almost disguising its shape. Once in the nest the *Melöe* larvæ quit their bearer, and remain in the interior, feeding upon the stores which had been laid up by the bee for the future young

In its perfect state, the oil beetle is chiefly remarkable for the yellowish fluid which it exudes from the joints of the limbs if handled, and which, in olden times, was considered as a specific for toothache.

The Meal-worm (*Tenebrio molitor*), the larvæ of which are in such request among bird-fanciers as food for their pets, also belongs to this group.

We now come to the enormous group of RHYNCHOPHORA, or Weevils, which may be distinguished by the formation of the head, which is prolonged into a kind of beak, or *rostrum.* The word 'rhynchophora' (*i.e.*, 'snout-bearers') refers to this structure. In the greater number of species the antennæ are elbowed.

In this country, the weevils number some five hundred species, mostly of small size, averaging, perhaps, the sixth of an inch in length. Abroad, however, and more especially in tropical countries, their numbers are very considerably augmented, and they attain to far greater dimensions than is the case with our own species. Some of the forms, too, are especially striking.

Amongst the weevils are included many which must be ranked among the direct enemies of man, their ravages causing the annual loss of many thousands of pounds of money. The most terrible of these, perhaps, are the two Corn Weevils (*Calandra granaria* and *oryzæ*), which cause almost immeasurable damage in granaries, both of British and foreign grain. They are both small insects, barely one-eighth of an inch in length. The first-named is of an uniform dark brown hue, and is rather the larger of the two; the ground colour of the latter is also brown, the elytra being ornamented with four red spots. Neither of them is supposed to be indigenous to Britain, both being thought to have been accidentally introduced from abroad.

The destruction caused by these two tiny insects is almost beyond belief. We read that they are 'screened,' or sifted, from the corn literally by the ton, and when we consider the quantity of grain which must have been devoured by these insects before they attained to their perfect state, we can easily imagine the terrible havoc which they cause.

The corn weevils are most prolific insects, and it is said that the progeny of a single couple will amount to as many as six thousand beetles in the course of a single year. The eggs are deposited singly by the parent insect, one in each grain of corn, the interior of which is entirely hollowed out by the larva, the mere shell only remaining untouched. When full-fed, it changes to the pupal condition within the grain of corn upon which it has been feeding, remaining therein until it reaches the perfect state.

Owing to the difficulty of separating the damaged corn from that which is unhurt, it is by no means easy to put a limit to the ravages of these insects, and the only method of doing so would appear to be by destroying the whole of the weevilled grain by means of fire. In the course of a few years their numbers would naturally be considerably diminished, and we might hope, in time, to see the almost total extinction of these destructive little pests.

A very well-known beetle of this group is the Nut Weevil (*Balaninus nucum*), with which most of my readers have probably, at some time or other, been acquainted in a manner the reverse of pleasant. Most people know the disgusting flavour of a 'bad' nut, in which a nauseous dust has taken the place of the sweet kernel.

This unpleasant transformation is owing to the nut weevil, which introduced an egg into the fruit while it was yet soft, the young larva devouring the kernel, and filling the shell instead with its bitter black frass. When full-fed, the grub gnaws its way through the shell, leaving a small round hole as the only indication of its ravages, and falls to the ground, where it undergoes the remaining phases of its development.

A similar insect attacks cork, and is the cause of the nauseous flavour in 'corked' wine.

The insect itself is a roundish creature, of a dark reddish-brown colour, prettily mottled with black and white markings. The beak is peculiarly long and slender, and is curved downwards from about the middle. It is slightly larger than the generality of weevils, being rather more than a quarter of an inch in length.

The most destructive of our British wood-boring beetles is the little insect known as *Scolytus destructor*, both of which titles are singularly appropriate, the former signifying a winding passage, and referring to the tunnels bored by the beetle, while the application of the second is evident enough.

Elm-trees are the chief sufferers from the ravages of this beetle, which drives its tunnels in every direction, forming a perfect network of sub-cortical passages, and finally entirely stripping the lower part of the tree of its bark. It is far from unusual to see a tree entirely denuded of bark to the height of some eight or nine feet from the ground, while the wood is completely covered with the burrows of the *Scolytus.*

Next we come to the LONGICORNES, or Long-horned Beetles, so called from the length of their antennæ, which are almost invariably thread-like, and are never clubbed at the tips.

The larvæ of the longicornes being wood-borers, the beetles are, of course, more or less destructive, although, owing to their comparative scarcity, we do not suffer very greatly, in this country, from their attacks. Residents in the tropics, however, might tell a different tale, for in equatorial countries the longicornes increase to a wonderful degree, both in numbers and size.

The two best known of our British longicornes are undoubtedly the Musk and the Wasp Beetles.

The former of these (*Cerambyx*, or *Aromia*, *moschata*) is usually common in the neighbourhood of willow-trees, upon the wood of which the larva feeds. It is rather a large insect, being generally about an inch and a quarter in length, exclusive of the antennæ, and is of a bright metallic hue, either green or brassy.

Its chief peculiarity lies in the powerful musky odour which proceeds from the body, and which is produced, although in a lesser degree, by several other beetles, of which the well-known Tiger Beetle is one. So powerful is this odour, that the presence of the beetle can be detected at a distance of several yards. If the insect is handled, too, the scent clings about the fingers for some little time.

The musk beetle also possesses the power of producing an audible sound, by the friction of the harder parts of the body against each other. The sound is short, sharp, and shrill, and is repeated in rapid succession, sufficiently loudly to be audible at some little distance.

The Wasp Beetle (*Clytus arietis*), although not more common than the Musk, is, as a rule, far more often noticed, its bright colours and active movements, so diametrically opposed to the sluggish habits of the latter insect, rendering it a very conspicuous object.

It is a handsome insect, and well deserves its popular title, the black and yellow elytra bearing a strong resemblance to the markings of the insect from which it derives its name.

The last but one of the groups of the coleoptera, viz., the PHYTOPHAGA, or 'plant-eaters,' comprises some of the most beautiful of all the British beetles. To this group belong the Chrysomelas (*i.e.*, 'golden apples'), whose polished forms look like so many shining gems; the exquisite Donacias, whose metallic bodies stud the stems of the water plants, and many others of equal beauty.

One of the most familiar *Phytophaga* is the well-known Asparagus Beetle (*Crioceris asparagi*), with its crimson thorax, and yellow and black elytra, which is so common upon the plant after which it is named, and which is so cordially detested owing to the mischief it causes. The Bloody-nose Beetles (*Timarcha*) too, with their curious habit of exuding a drop of reddish fluid from the mouth if handled; and the *Halticidæ*, those tiny little beetles with so wonderful a power of leaping, also belong to this group.

The last group consists of the PSEUDOTRIMERA, or insects with 'false three-jointed' *tarsi*, so called because the tarsi are formed of four joints, whereas they only appear to possess three.

With a few exceptions, the beetles of this group are popularly known as Lady-birds (*Coccinellidæ*), insects which are more valuable to us than most of us have any idea of. But for the lady-birds, our hop-grounds would be ruined, and we should scarcely be able to keep a fruit-tree in our orchards, or a flower in our gardens. For the devouring aphis, or 'blight,' as we often term it, would be master of the situation, and would pursue its destructive course unchecked by the attacks of the ravenous lady-birds, which, both in the larval and perfect states, destroy it in myriads, and keep its numbers within proper limits.

There are several species of lady-birds inhabiting Great Britain, some of which are exceedingly common, while others are correspondingly rare. Our two commonest species, *Coccinella bipunctata*, popularly known as the 'two-spot,' and *C. variabilis*, vary in colour and markings to an almost inconceivable degree—so much so, in fact, that a drawer might almost be filled with specimens of these beetles alone, no two of which should exactly resemble one another.

In some years these beetles are far more plentiful than in others, and it will be generally found that, when the aphides are unusually numerous, there is a corresponding increase in the numbers of the lady-birds, which serve to keep down the ravages of the destructive little creatures.

The next paper of this series will be devoted to a description of the *Euplexoptera*, or Earwigs, and the *Orthoptera*, comprising the Cockroaches, Grass-hoppers, etc.

THE DERMAPTERA AND ORTHOPTERA.

PART I.

UNTIL of late years, the true situation of the earwigs in the insect world was a matter of considerable doubt. Some entomologists considered that they should be ranked among the beetles; others that they formed a part of the *Orthoptera* (or Cockroaches, etc.), while others again held them to belong to a separate order, which they entitled *Dermaptera*, a word signifying 'skin-winged,' which was applied to them on account of the peculiar structure of the elytra.

The first of these theories, viz., that the earwigs constituted one of the families of the *coleoptera*, was easily disproved as soon as the life-history of these insects was enquired into; for it was found that the pupæ, instead of passing through that stage of their development in a state of quiescence, as is the case with the beetles, were fully as active as the perfect insects, differing only in the undeveloped state of the wings. Among various other distinctions, also, the formation of the elytra held a prominent place, those organs being in the earwigs soft and leathery, crossing each other slightly at the tips, and not entirely covering the wings, while in the beetles they are hard and horny, and parallel for the whole of their length, the wings, also, being entirely concealed.

From the *Orthoptera*, which in other points they closely resemble, they differ in the manner in which the wings are folded, those of the cockroach, cricket, etc., lying in longitudinal folds alone, while in the earwigs they are folded transversely, as is the case with the beetles. The elytra, too, of the *Orthoptera* are strongly veined.

These points of difference being taken into consideration, it was determined that the earwigs constituted a separate order, and the title *Dermaptera* was for a long time applied to them. Some confusion, however, arising as to the insects comprised in the group, many entomologists including the cockroaches and others among the *Dermaptera*, the word *Euplexoptera*, or 'beautifully-folded wings,' was suggested by Professor Westwood for the earwigs, and this arrangement is now almost universally recognised.

Concerning the popular name, too, a great deal of misconception has arisen. More especially among the lower classes, the earwig is held in considerable dread, owing to its reputed aptitude for entering the human ear, and penetrating by some remarkable channel to the brain, which organ is supposed to be so affected by the presence of the insect that madness immediately follows. It is, of course, unnecessary to point out the impossibility of such a proceeding on the part of the earwig, no passage existing between the brain and the external ear, and the entrance of the insect for more than a very short distance being completely out of the question.

A more probable derivation of the popular title is from the two words 'ear' and 'wing,' *i.e.*, 'earwing,' the form of the wing of the earwig being almost exactly that of the human ear.

There must be few who are not practically acquainted in some degree with the common earwig. In many ways the insect is objectionable enough, its destructive habits, among fruit and flowers especially, causing it to be regarded with almost universal disfavour. Yet the earwig, like every other insect, is worthy of the most detailed study and examination, and the more time we devote to its structure and habits, the more points of interest do we discover.

The most superficial observer can scarcely fail to notice the remarkable structure placed at the extremity of the body, which closely resembles a pair of curved forceps. The popular idea, leaping at once to the conclusion that everything connected with the insect must of necessity be prejudicial to mankind, holds that these forceps are created for the express purpose of nipping human fingers. As barely one earwig in ten thousand ever comes into contact with a human being, it is scarcely likely that such weapons would be furnished to the insects against a foe they were so little likely to meet, and the theory is therefore hardly tenable. Their real object we shall presently see.

The elytra, as before stated, are of a soft and leathery nature, therein differing considerably from the hard and horny wing-cases of the beetles. In appearance they somewhat resemble the corresponding organs of the *staphylinidæ* (which, it will be remembered, form one of the principal groups of the coleoptera), being very small in proportion to the size of the wings which they protect, and leaving several segments of the abdomen entirely uncovered.

The wings themselves are most wonderful and beautiful objects, although few have an opportunity of seeing them when thoroughly extended. And for this reason, that the membrane of which they are composed is of so delicate a nature, and the innumerable folds are so difficult to expand, that it is almost impossible to spread them without completely tearing them to fragments; and the still more difficult task of re-folding them and packing them away beneath their cases has probably never yet been performed by man.

How, then, does the insect contrive to perform these operations, neither of which occupies more than a second or two from first to last?

It will be remembered that the *staphylinidæ*, as mentioned in one of the previous papers of this series, are accustomed to fold their wings by the assistance of the extremity of the body, which is bent over the back for that purpose. The same is the case with the earwig, which is enabled to fold its infinitely more complex wings by the assistance of the tail forceps.

The rapidity with which the operation is completed is perfectly marvellous. The insect alights, gives the wings a rapid shake, which has the result of throwing them into longitudinal folds, turns the body over the back, and daintily folds them up with the forceps; it then pushes them beneath the elytra, which it finally smooths over them, the whole operation consuming barely two or three seconds.

In order to facilitate the folding of the wings, these organs are formed of a number of strong nervures, running longitudinally, between which is spread the membrane of which the wings are composed. These ribs, or nervures, are furnished with a double set of leathery hinges, so that they can be folded back upon themselves in somewhat the same manner as the cover of a book.

The life-history of the earwig, at least as regards one point, is probably unique in the insect world.

It is a well-known fact that insects, as a general rule, never see their own offspring; far less do they tend them and bring them up. The object of their existence seems to terminate as soon as the eggs are deposited, the parent insect seldom surviving that operation for more than a few hours. In very few cases is she still living when the eggs are hatched, the larvæ being able from the moment of their birth to take care of themselves.

Some insects, such as the bees and ants, are perfectly helpless while in their larval condition, and are therefore nurtured and tended by perfect insects. But not by the parents, although they may still be living, their object in life seeming to be entirely confined to the deposition of eggs.

The earwig, however, furnishes a remarkable exception to this rule, for the maternal parent not only continues to exist after her eggs are deposited, but actually watches over and guards her progeny from danger. It is by no means unusual, in the early spring, on turning over a stone or log, to see the parent earwig sitting over and guarding her eggs, or, a week or two later, her young brood. I have myself found as many as five or six batches of eggs, each guarded by the mother, in the course of a single day.

The parent insect may be repeatedly removed from her post, but will as often make her way back to the spot, giving even her very life in behalf of her offspring.

The eggs are usually placed by the parent earwig in some moist and damp spot, and are shifted to another situation if the locality should show signs of becoming too dry for their welfare.

Both the larvæ and pupæ of the earwig closely resemble the imago, and by a casual observer would probably be considered as adult insects. The larvæ, however, are without traces of wings, and the pupæ only possess those organs in a rudimentary form, while the tail forceps are without the strong curve found in those of the perfect insect. The antennæ, too, are formed of fewer joints.

Several species of earwigs inhabit Great Britain, all of them, with a single exception, being tolerably common. Most of them, however, are so similar in habits and appearance to the common species (*Forficula auricularia*) that a separate description is unnecessary, and we therefore pass to the solitary rarity in the group, namely, the Giant Earwig (*Labidura gigantea*).

As its name implies, this insect is far superior in size to the commoner species. It is an inhabitant of the sea-coast, dwelling among the rocks during the day time, and venturing out at night in search of prey.

The forceps of the insect, which are very long in proportion to the size of the body, are of a rather remarkable form, being almost straight, without the decided curve found in those of our common species. In the female, these organs are comparatively small.

Among the foreign earwigs, also, there is, curiously enough, both in form or habits, but little variety to what we might expect when we take into consideration the strange developments of structure found in insects of other orders. One species is, however, remarkable for the enormous size of the forceps, which, at any rate in the male insect, fully equal the entire length of the body.

We now come to the *Orthoptera*, or 'straight winged' insects, so called because the wings can be folded longitudinally only, and not transversely, as can those of the beetles and earwigs. The order comprises the insects popularly known as Cockroaches, Grasshoppers, Crickets, Locusts, etc.

Among the other distinguishing characteristics of the insects of this order may be mentioned the construction of the elytra, which are tough, leathery, and strongly veined, and the formation of the mouth, which is furnished with jaws suitable for cutting the substances which are selected as food. This formation of the jaws effectually distinguishes the *Orthoptera* from the *Heteroptera*, which otherwise they closely resemble, and which are provided with a beak, or proboscis, through which fluids can be sucked into the mouth.

THE *Orthoptera* are usually considered as being divided into four groups, the first of which, viz., the *Cursoria*, or 'runners,' comprises the rather unpleasant insects bearing the popular title of Cockroaches.

Male and Female Cockroaches.

Our common British cockroach must be familiar to all, for, although it is not an indigenous inhabitant of Great Britain, there is now hardly a part of the country in which it is not to be found in abundance.

The insect is perhaps more commonly known by the erroneous appellation of 'black-beetle,' a very mistaken title, the insect being neither black nor yet a beetle.

There are few creatures more thoroughly detested than the cockroach, and certainly not without some reason, for it cannot be denied that it is both mischievous and destructive, as well as being possessed of a most unpleasant odour. Yet these disadvantages are fully counterbalanced by the benefits which it confers upon us, and to which we shall shortly have occasion to refer.

There are comparatively few houses which are not infested by these insects. During the day time they keep carefully out of sight, knowing instinctively the danger of making their appearance. As soon, however, as the house is closed for the night, they emerge from their retreats, and proceed to forage in search of food. If a light be suddenly brought into a room, the kitchen more especially, during the hours of darkness, a strange spectacle presents itself. The floor and walls are almost black with cockroaches of all sizes, scampering with all possible speed to their holes, or shrinking in the corners in hopes of avoiding observation.

Among these cockroaches will be found four distinct forms, viz., the larva, the pupa, the perfect male, and the perfect female.

The larva and pupa, as is the case with all the *orthoptera*, closely resemble the perfect insect, the chief point of difference lying in the absence of wings.

The two sexes of the adult insect differ very considerably in appearance. The male, which is by far the more handsome, may be easily distinguished by the superior length of his antennæ, and by the possession of wings, which, in the female, are present only in a rudimentary form; in general appearance, too, he is slighter and more graceful. The head, in both sexes, is only partly visible, being almost entirely concealed beneath the broad and shield-like thorax. The colour of the insects is a rich brownish red.

It is, at first sight, somewhat difficult to understand how the cockroach should have contrived to spread itself so completely over the country. In the first place, of course, it must have been imported by means of ships from the countries of which it was a native. But, so are many other insects, which, although common enough in the neighbourhood of the docks, are seldom or never found at any distance from those localities.

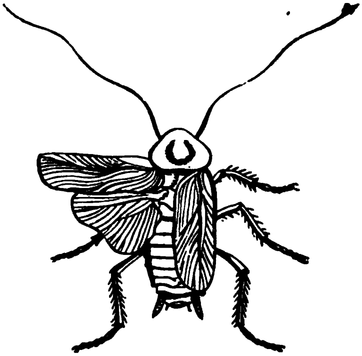
With the cockroach, however, it is a different matter. The insect is by nature a lover of warmth, and is therefore greatly attracted by the heat of the kitchens of the neighbouring houses. Once having taken up its quarters, it is easily transferred from house to house in numberless ways, chief among which may be mentioned the laundress' baskets, and the bundles of firewood from the grocers' shops. Hampers, etc., sent by rail, are tolerably certain to harbour a number of the insects, so that their talent for spreading themselves over the country is easily explained.

Once fairly within a house, it is an almost impossible task to thoroughly exterminate them. Insect powders may be employed with apparently the best results. Every morning the floors are found to be strewed with the dead and dying in all stages of development. Jars of treacle or stale beer are placed in the corners of the room, and are found almost choked up with corpses in the morning. Daily their numbers diminish, and in a week or two the house is supposed to be cleared of the pests, and the campaign is relaxed.

A month afterwards the insects are as numerous as ever. Yet the baskets and firewood have been carefully examined, and the greatest precautions taken against introducing even a single specimen into the house. Whence, then, have these myriads appeared?

The matter is easily explained. The insect powders did their duty well enough, and destroyed every living insect. But they could not damage the eggs which had been already deposited, and which, of course, escaped without the slightest injury.

The manner in which the eggs of the cockroach are laid is most singular. Unlike those of other insects, they are enclosed in a tough, horny case, shaped somewhat like an oval purse, with a serrated ridge running along one side, and corresponding to the clasp.



Male Cockroach with wings spread.

Each of these cases contains sixteen eggs, each in a separate cell, and placed in two longitudinal rows, lying in much the same manner as do peas in a pod. When the time approaches for the eggs to hatch, the case opens at the clasp, so to speak, and the young larvæ emerge, their late habitation again closing and seeming to all appearance entirely unchanged.

How these curious egg-cases, which are rather more than two-fifths of an inch in length, are produced has not yet been discovered.

We must not conclude without a few words concerning the services rendered to mankind by the cockroaches.

In the first place, these insects perform the important duties of scavengers. Every piece of wasted food, every scrap upon the floor serves them for provisions, and material is thus removed which, if allowed to remain and putrefy, would probably be productive of serious consequences.

In the next place, cockroaches, although unpleasant enough in their way, are the greatest foes of other and still more disagreeable insects, devouring them with the greatest eagerness, and never allowing one to remain alive in the house in which they have taken up their quarters. So much is this the case, that cockroaches are actually welcomed on board ship, the sailors knowing that they will shortly free the vessel from the insect pests which had before been so troublesome.

Although the common cockroach is not a native of Great Britain, there are other species of the same genus (*Blatta*) which are indigenous to our islands. One of these is a cockroach without a popular name, but which is scientifically known as *Blatta ericetorum*. This is quite a small insect, being scarcely one-third of an inch in length, and of a pale yellow colour. As its name implies, it is found amongst heath.

Another of the outdoor species is the Field Cockroach (*B. germanica*), a doubtful British native. The egg-case of this insect has the peculiarity of containing no less than thirty eggs.

The Cockroaches were formerly supposed by many entomologists to constitute a distinct order, which they termed *Dictyotoptera*, a word signifying 'reticulated-winged,' and which was applied to them on account of the curiously veined elytra.

No. VIII.—THE ORTHOPTERA.

Part II.

THE strange insects bearing the popular title of Mantis are not represented in this country, although in many parts of the world they are plentiful enough. These insects constitute the second group of the *Orthoptera*, and are scientifically known as the *Raptoria*, or Snatchers.

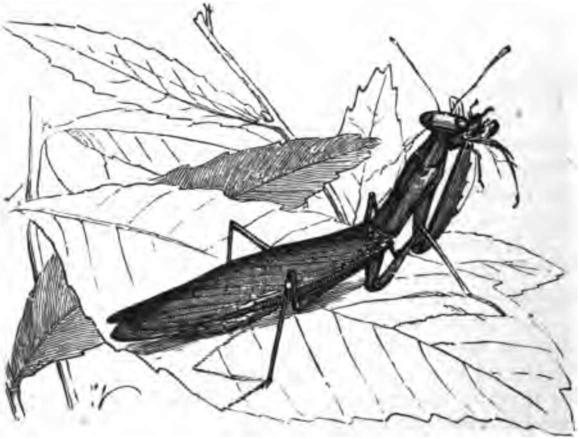
This name they derive from the singular structure of the fore-legs, which are the weapons used in the capture of the prey.

The *coxa*, usually a comparatively insignificant joint, as far as size is concerned, is in these limbs developed to a considerable degree, almost equalling the thigh in dimensions. The thigh is strong, broad, and flat, with a deep groove running along it, this groove being furnished on either side with a number of sharp teeth. The *tibia* is also armed with spikes, and closes into the groove found in the *femur.*

When the mantis is in search of prey, and catches sight of an insect within a convenient distance, it creeps warily up, holding the fore-legs raised above the head, as shown in the illustration. When within striking distance, a rapid stroke is made, the insect is enclosed between the fore-legs, and, the tibiæ being drawn into the groove provided for them, the prey has no chance of escape.

This peculiar attitude of the fore-limbs was formerly thought to be that of prayer, and the insect was termed the Praying Mantis accordingly.

These insects are still regarded with superstitious feelings in many parts of the world. In some countries, for instance, it is thought that any one losing his way in the forest, and inquiring of the first mantis he sees, will be instantly directed by the insect, which is supposed to point out with the fore-limbs the necessary direction.



Praying Mantis.

Most of these insects resemble in colour the foliage of the trees which they frequent, some species even changing their hues in accordance with the tints of the leaves at different periods of the year. It may thus be imagined, when the protective colours and the peculiar form are taken into account, that the insects are by no means easily to be detected.

Passing by the next group, namely, the *Ambulatoria*, which comprises the various Leaf and Walking-stick insects, none of which inhabit Great Britain, we come to the fourth and last division of the *Orthoptera*, viz., the *Saltatoria.*

As their name implies, the insects of this group, which includes the grasshoppers, locusts, etc., possess the faculty of leaping from the ground, sometimes to a considerable height.

As is the case with all leaping insects, the power lies in the hinder limbs, the thighs of which are long, and of very great comparative size.

The first family of this division comprises the *Achetidæ*, or Crickets, with the commoner species of which almost every one is more or less acquainted. These insects may be recognised by the size of the antennæ, which are generally almost equal in length to the body, and by the structure of the wings, which, when folded, are not entirely concealed by the elytra, but project for some distance beyond them. The males are furnished with two long antenna-like bristles at the end of the body, which appear to warn the insect of any danger approaching from behind; in the female the place of these organs is taken by the ovipositor, which is usually of considerable length.

The shrill noise uttered by the male insect is produced by the vibration of the elytra against one another, a rather curious modification of those organs giving rise to the sound. In each wing-case, a stout nervure starts from a thickened spot, some little distance from the base; in the right elytron the under side of this nervure is regularly notched, as though it had been grooved with a file.

When the insect is at rest, and the wings closed, the right elytron lies above the left in such a manner that the notched nervure rests upon the corresponding one in the left wing-case. The elytra are then put into rapid motion, and the grooved nervure rasps upon its fellow, with the result of causing the shrill sound with which we are so familiar.

The elytra differ to a considerable extent in the two sexes, and in some species form almost the only means of distinguishing between them.

The most abundant of our native species is, of course, the common House Cricket (*Acheta domestica*), which needs little or no description.

One peculiarity, however, lies in the structure of the ovipositor. This organ is very long and slender, and is terminated by a broad and sharpened tip, looking somewhat like the head of a spear. This apparatus is double, each of the parts being hollow, with a deep groove running along the entire length, thus forming a tube through which the egg can pass.

The spoon-shaped termination is also double, or rather quadruple, each of the parts being cleft along the centre, and opening and closing at the will of the insect. By this means the egg can be placed in a narrow aperture, being held, meanwhile, by elastic springs, which can be relaxed or contracted as necessity requires.

Another of our British species is the Field Cricket (*Acheta campestris*), which, although plentiful enough in many parts of the country, is, owing to its cautious and retired habits, far more often heard than seen.

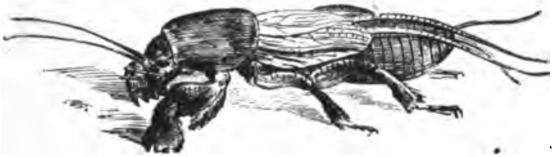
This insect is not gregarious, each specimen living in a separate burrow, which it seldom leaves, except at night.

Being very wary creatures, retreating into their tunnels at the mere sound of a footstep, they are not easily obtained. Strategy, however, will often succeed where open attack fails. For this cricket is easily roused to anger, and if a grass stem, or other similar object, be poked down the burrow, is sure to seize the intruder with its powerful jaws; a sharp jerk will then usually draw the insect from its retreat before it is able to relinquish its hold.

Like the domestic cricket, this insect is of a very quarrelsome nature. If a number of specimens are placed together, a battle is sure to ensue, the combatants attacking one another with such fury that limbs are often torn from their bodies, the weaker insects usually paying the penalty of their rashness with their lives.

Amongst the foreign crickets must be mentioned the extraordinary species known as *Acheta monstrosa*, which is remarkable for the structure of the claws, and also for the great length of the antennæ, each of which is composed of the wonderful number of two hundred and forty joints. The burrows sunk by this insect sometimes attain three feet in depth.

Closely allied to the preceding insects, although placed in a different genus, is the curious Mole Cricket, Croaker, or Chur Worm, as it is often called (*Gryllotalpa vulgaris*).

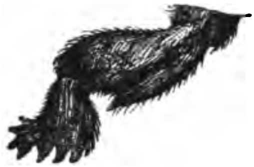


Mole Cricket.

This insect well deserves its popular title, bearing a strange resemblance, both in form and habits, to the animal from which it derives its name.

The fore-legs are constructed expressly for the purpose of burrowing through the earth, the *tibiæ* being broad, flat, and powerful, and armed with long and sharp claws, and the form of the limb almost exactly corresponding with that of the digging leg of the mole.

The *tarsus*, or foot, is small, and of little use during the operation of tunnelling, being packed out of harm's way beneath the broad *tibia*. This curious apparatus is well represented in the accompanying illustration.



Digging Leg of Mole Cricket.

In this insect the female is not provided with an ovipositor; the only method of distinguishing the sexes by outward examination lying in the structure of the elytra, as mentioned above, the notched nervure being present in the male alone. It is a curious fact that in the male the right elytron overlaps the left, while in the female the reverse is the case.

The colour of the insect is a rich reddish-brown, becoming considerably darker upon the thorax, and paling almost to yellow beneath the body. The elytra are also paler, with dark nervures.

The mole cricket is generally to be found in sandy soils, where it tunnels to considerable distances beneath the surface. A separate chamber is always constructed for the reception of the ova, and is situated near the surface of the ground, in order that the heat of the sun may penetrate to the cavity, while the eggs are protected from foes. The entrance to this cell is always at some little distance, a tunnel connecting it with the outer world.

Although this insect resembles the mole in so many points, it differs from that animal in one important particular, viz., the benefits it confers upon mankind.

The mole, as has already been explained in these pages, is of the greatest service to agriculturists, its numberless tunnels answering the purpose of a most complete system of subsoil drainage, the earth brought to the surface serving to renew the soil, while the food of the animal consists chiefly of the grubs of those insects which find their food in the roots of the various crops, and whose destruction is therefore a matter of the greatest importance.

The mole cricket, however, affords us none of these benefits. Its tunnels are too few and slight to be of any value as far as drainage is concerned, and instead of preying upon the insects which damage the crops, it joins forces with them, feeding chiefly upon the roots of various vegetables. When the insects are plentiful, they have sometimes been known to cause considerable damage to garden plants of different kinds.

Their diet, however, is not always of a vegetable nature, for they have often been known to feed upon raw meat. Occasionally, also, they evince cannibalistic propensities, and attack their weaker brethren, the conqueror invariably devouring his vanquished foe.

We now come to another family, namely, that of the *Gryllidæ*, or Grasshoppers, our first example of which is the Great Green Grasshopper (*Acrida viridissima*), which is a tolerably abundant insect in most parts of the country.

The colour of this species is the most vivid green, which, however—as is almost invariably the case with insects of that hue—fades almost immediately after death, and becomes a dingy yellow-brown. Owing to the similarity of colour between the insect and the leaves of the trees which it inhabits, it is comparatively seldom seen, in spite of its abundance, even a practised eye often passing it by without detection.

The sound emitted by this insect is very loud and shrill, and can be heard at a considerable distance. It is a curious fact that, to some, this sound, powerful as it is, is perfectly inaudible, the note being too shrill for the auditory nerves to transmit to the brain. A friend of my own is included among this category of individuals, although, strangely enough, he can detect the cry of the bat, which is of an even higher pitch, with the greatest ease.

The young of this grasshopper bear a strong resemblance to gigantic aphides, furnished with leaping limbs. They differ from the perfect insect in the absence of wings, and, in the females, of the ovipositor, which does not make its appearance for seven or eight weeks from the time of the commencement of the larval existence.

In the perfect insect this organ is formed in a somewhat singular manner, consisting of a number of blades, which can be separated in order to allow the egg to pass between them.

Another species is the Tree Grasshopper (*Meconema varia*), which is generally to be found upon the oak. This species has the peculiarity of being perfectly silent.

We now come to the well-known Locusts, which, happily for us, are extremely rare in this country. However, a few specimens almost annually find their way to our shores, and many more are chronicled, almost any large insect doing duty as one of these creatures. Even such totally dissimilar insects as the Death's-head and Humming-bird Hawk-moths have more than once been mistaken for the genuine locust. Most of the true locusts which are found in this country belong to the same species, *i.e.*, the Migratory Locust (*Pachytylus migratorius*), a representation of which accompanies this article. The colour of the insect is a pale brown, the elytra being marked with darker spots; the wings, which are broad and powerful, have a slight greenish tinge.

The destructive nature of the locust is only too well known, and there is little need to enlarge upon it in these pages. I may, however, be permitted to quote a passage from Lady Brassey's well-known work, 'A Voyage in the *Sunbeam*,' with reference to their numbers.

Great Green Grasshopper.

'In the course of our ride, we saw in the distant sky what looked very much like a heavy, purple thundercloud, but which the experienced pronounced to be a swarm of locusts. It seemed impossible; but, as we proceeded, they met us, first singly, and then in gradually increasing numbers, until each step became positively painful, owing to the smart blows we received from them on our heads, faces, and hands. As the locusts passed between us and the sun, they completely obscured the light; a little later, with the sun's rays shining directly on their wings, they looked like a golden cloud, such as one sometimes sees in the transformation scene of a pantomime; and, at a greater distance, when viewed from the top of a slight eminence, they looked like a snowstorm, or a field of snow-white marguerites which had suddenly taken to themselves wings. When on the ground with their wings closed, they formed a close mass of little brown specks, completely hiding the ground and crops, both grass and grain. In riding over them, though not a quarter of their number could rise, for want of space in which to spread their wings, they formed such a dense cloud that we could see nothing else, and the horses strongly objected to face them.'

The same author also states that railway trains are sometimes stopped by these creatures, not so much from their numbers, as that, on account of the oil flowing from their crushed bodies upon the line the wheels will not hold the rails.

Only a year or two ago, also, during the Russo-Turkish war, the advance of a large army was stopped by a vast flight of locusts, which rendered progression utterly impossible until, after the lapse of a considerable time, their numbers had somewhat diminished.

Some idea of their multitudes may be formed from the fact, related by a modern traveller, that, after a severe storm, the locusts were heaped up into a vast bank three or four feet in height, and fifty miles in length.

Migratory Locust.

It seems strange that insects furnished with such broad and powerful wings as are the locusts, should yet possess so little power of directing their flight. Yet such is the case, and the insects are unable to withstand the force of even a gentle breeze, being carried about by the wind and forced to travel in the direction which it is blowing, always seeming to keep their heads to the wind and to drift backwards. For this reason great numbers perish by being blown out to sea, their dead bodies, when washed up by the tide, often forming a high wall many miles in length. They are also peculiarly susceptible to the effects of cold, and perish in multitudes should there be any great falling off in the temperature.

Although to civilised man the locust must be regarded as an unmitigated pest, it is not so to him when in a state of nature. Many savage tribes, indeed, consider a flight of these insects in the light of a blessing rather than a curse. They have no crops, and therefore nothing to lose by the ravages of the insects. On the contrary, they gain by their advent, collecting the insects in vast quantities, and using them as food.

The mode of capture is simple in the extreme. Large fires are lighted, and fed with damp wood; this, of course, causes a thick smoke to ascend. The locusts, powerful insects as they are, have but little power of directing or altering their flight, and fall to the ground in myriads, stupefied by the smoke, when they are collected without difficulty.

By these people, the bodies of the locusts, when cooked, are considered as positive dainties, and the approach of a swarm is hailed with the greatest delight. Travellers, however, differ greatly in their accounts respecting this strange diet, some saying that it is almost nauseous, while others hold a diametrically opposite opinion. In one book we read that the flavour of the insects can only be compared to a mixture of linseed cake and burnt feathers, while another tells us that locusts form an admirable substitute for shrimps, from which creatures the sense of taste is unable to distinguish them. *De gustibus non est disputandum.*

Many other species of locusts are found in different parts of the world, none of them, however, causing such terrible havoc as that which has been above described, and which may fairly rank as the most destructive insect upon the face of the earth.

No. IX.—THE THYSANURA AND NEUROPTERA.

BY some authors considered as merely a branch of the *Orthoptera*, the small and insignificant order of the *Thysanoptera*, or *Thysanura*, deserves a passing mention.

The insects belonging to this order, which are popularly known as Thrips, are chiefly remarkable for their ravages in greenhouses, etc., where, in spite of their minute size, they often cause considerable havoc. To the naked eye many of these insects are almost invisible, our largest British species barely reaching the twelfth of an inch in length. When placed beneath a tolerably high power of the microscope, however, they become very interesting objects.

The wings are seen to be curiously fringed with long tassel-like hairs, whence the title '*thysanoptera*'—*i.e.*, 'tassel-winged'—was given to the order. The parts of the mouth are of a somewhat anomalous character, the slender, bristle-like jaws resembling those of the *Hemiptera*, while the other organs are more like those of a mandibulated insect. Owing partly to this curious structure, and partly to the nature of the metamorphoses, the position of these tiny insects was for many years doubtful, but it now seems tolerably certain that they constitute a separate order, and are rightly placed in their present situation.

The thrips have occasionally caused considerable damage to the wheat crops, both in this country and on the Continent; fruit of various kinds also sometimes suffers from their attacks.

The *Neuroptera—i.e.*, 'nerve-winged' insects—may be easily recognized by the wonderfully complicated system of nervures which supply the necessary rigidity to the wings. All winged insects possess these nervures in some form or other, but in none are they so highly developed as in the species composing this order, whose wings are divided into a vast number of small cells by the network of nerves. Generally speaking, all four wings are of equal size.

Larva of Dragon-fly (showing mask).

Although the *Neuroptera* are not largely represented in Great Britain, our species are, as a rule, both large and plentiful, and are therefore familiar to almost every dweller in the country.

The Stone-flies, which are so largely utilized by anglers as bait, form the first family of the order. These insects may be found in great numbers in the neighbourhood of running water, resting sluggishly upon stones and other objects upon the banks of the stream.

During the earlier stages of their existence, the stone-flies lead an aquatic life, the eggs, which are enclosed in a blackish membrane, being deposited in the water by the female insect. It is a curious fact that these eggs are carried about by the parent for several days, just as is the case with those of the cockroach.

The larvæ usually conceal themselves beneath submerged stones, or in some other sub-aquatic retreat, and prefer those parts of the stream where the water runs with the greatest force.

In the *Ephemeridæ*, commonly known as May-flies, we find many points of interest.

The perfect insects differ from the generality of the *Neuroptera* in the size of the hinder wings, which are considerably smaller than the anterior pair. Owing to this peculiarity, these insects have sometimes been considered as forming a separate order, to which the title of *Anisoptera—i.e.*, 'unequal-winged' insects—was applied.

Another peculiar feature of the May-flies lies in the absence of a mouth in the perfect insect. It is true that the parts of the mouth may be distinguished by the aid of the microscope, but they are only found in a rudimentary condition, and are utterly unfit for the reception of food.

At the extremity of the body are seen either two or three long filaments, by means of which the insect may be readily recognized.

Although the existence of the *Ephemera* is considered at most to extend over a single day, the life of the insect in reality embraces a much longer period of time, two years being occupied in the preliminary stages of its development. The larva, which, like that of the stone-fly, is an inhabitant of the water, constructs for itself a tunnel in the mud, formed with two outlets, and very much resembling in form the capital letter U; its food consists of decaying vegetable matter.

In appearance the larva of the May-fly is somewhat remarkable, being provided with two rather long antennæ, which far exceed in dimensions those of the perfect insect; the extremity of the body is furnished with three fringed bristles, or *setæ*, and along each side of the body runs a series of thin plates, in which are the gills.

The pupa differs in outward form in a very slight degree from the larva, the chief distinction lying in the hump upon the thorax, in which are concealed the rudiments of the future wings.

When the preliminary stages of its existence are completed, a very singular circumstance takes place.

The pupa leaves the water, and, ascending the stem of some plant, undergoes its change to what we might consider to be the perfect insect, the wings being fully developed, and the insect possessing and using the power of flight.

Yet this, strange to say, is not its final form, for, after a short space of time, the skin again splits, and the insect crawls forth, leaving its cast-off garment behind it. The wings are now lighter, and of a more delicate nature, and the filaments at the end of the body considerably increase in length.

This intermediate stage is scientifically known as the *pseudimago*, or 'false-perfect' insect, and popularly as the 'Green Drake' of anglers, the perfect insect itself bearing the title of Grey Drake.

Demoiselle Dragon-flies.

Once having attained to the perfect condition, the life of the May-fly is a question of only a few hours, its existence seldom exceeding the duration of a single day.

We now come to perhaps the most interesting group of all the *Neuroptera*, namely, the *Libellulidæ*, or Dragon-flies.

Swift and active of wing, and possessed of insatiable appetites, these creatures, alike in their larval, pupal, and perfect stages of existence, are the very tyrants of the insect world, myriads of the inhabitants of the water falling victims to them while yet in the earlier stages of their existence, while the perfect dragon-flies are equally destructive among the denizens of air. Not even the swift-flying Scarlet Admiral butterfly can escape from them, its powers of flight being quite inadequate to allow of its escape from its active and vigilant foes. And the dragon-fly possesses the curious and probably unique faculty of reversing the action of the wings, and, without turning, the direction of its flight; so that it is able to pursue its quarry among the foliage of trees, etc., and thus prevent any chance of escape, while it is able to make its own retreat without the slightest difficulty.

In many parts of the country these insects are known as 'Horse-stingers,' owing to the very mistaken idea that they sting horses. There is not the slightest foundation for this idea, the dragon-fly being perfectly harmless excepting to the insects upon which it preys. It is true that, when captured and held by the wings, it will twist its long and slender body about in a manner very suggestive of the possession of a sting, and may thereby, very likely, induce its captor to restore it to freedom. But in reality there is no trace whatever of a sting, that weapon being found in some of the Hymenoptera alone, and, even then, only in the female insects.

The life-history of a dragon-fly is of a singularly interesting and remarkable nature.

The eggs are deposited in the water by the parent insect, which may often be seen resting upon some floating object, with the tip of her abdomen dipped below the surface. The larvæ shortly hatch, and at once enter upon the predacious life which they lead during the remainder of their existence.

For this predacious life they are admirably adapted in every way.

As many of the insects, and other inhabitants of the water, are possessed of considerable swimming powers, their own locomotive apparatus must be developed in a corresponding degree. Such we find to be the case, but in a manner wholly different to what we might reasonably expect.

If we place one of these larvæ in a glass vessel of moderate size, and watch its habits for a short time, we shall be surprised at the rapidity with which it passes through the water and alters its course at will. And, more remarkable still, the means of propulsion will be absolutely invisible, the insect appearing to move without exertion of any kind.

Let us sprinkle a little fine sand at the bottom or the vessel, and we shall quickly find a clue to the mystery.

We shall see that this sand is thrown up behind the insect at tolerably regular intervals, in somewhat the same manner as if we had discharged the contents of a syringe beneath the surface of the water, although, of course, upon a much smaller scale. Now let us take the larva from the water, and subject it to close examination.

We shall find, at the extremity of the body, an appendage consisting of five spike-like objects, which can be separated and closed at the will of the insect. Concealed by these is the entrance to a passage, sufficiently large to admit an ordinary pin, which runs through the centre of the abdomen for the greater part of its length. By the agency of this tube the insect is enabled to swim.

It will be seen that, if the tube is filled with water, and suddenly compressed, the force of the expelled fluid upon the surrounding water will propel the insect forward, just as a sky-rocket is driven into the air by the action of the ejected gases upon the atmosphere. This is the whole secret of the swimming powers of the dragon-fly larva, the tube being alternately filled with water and forcibly compressed by the powerful muscles of the abdomen.

The swimming tube also fulfils a second and equally important function, somewhat analogous to that performed by the gills of a fish

Although the dragon-fly larva requires a constant supply of oxygen, it is yet not obliged to seek it at the surface, as are the generality of water insects, but is enabled to extract the requisite amount from the water by means of the swimming tube. In the interior of this are placed the spiracles, instead of upon the outer surface of the body, as is usually the case.

Beneath the head of the dragon-fly larva, and extending as far as the junction of the first pair of legs with the thorax, will be noticed a curious horny plate. This can be unfolded by means of a pin, and will then be seen to consist of several joints, the last of which is furnished with a pair of powerful jaws.

This apparatus, which is known as the 'mask,' is used in seizing the prey. Swimming silently beneath its intended victim, the dragon-fly larva approaches within striking distance. The mask is then thrown sharply upwards, and the insect seized in the horny jaws. Once captured, the mask is contracted, and the victim held against the mouth, where it is retained until completely devoured.

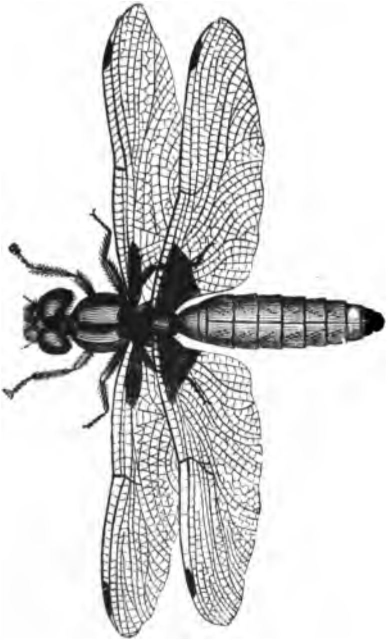
This larva is not a very handsome creature, being a slender insect, of a pale olive-brown colour, with rather long legs. The pupa is but little different, the methods of eating, breathing, and swimming being precisely the same, and the only apparent alteration consisting in the appearance of a hump upon the thorax, in which the future wings are enclosed.

When the time approaches for its change into the perfect condition, the pupa becomes sluggish and entirely loses its appetite. Warned by instinct, it crawls up the stem of some water-plant, leaves its late element behind it, and emerges into the air, where it rests for a few moments, clinging tightly to its foothold.

After the lapse of a few minutes, the skin bursts, and the dragon-fly crawls forth, its wings still limp and crumpled, and as yet unfit to bear their owner through the air. By degrees, however, the folds disappear, the membrane acquires the necessary strength, and the dragon-fly launches itself into the air, and immediately sets forth in search of prey. Although its development is completed, its appetite is as voracious as ever, and insect after insect falls a victim to its insatiable hunger. Even if captured and held between the fingers, it will continue to feed, and will devour more bluebottles than its captor will care to supply.

We have many species of dragon-fly in this country, most of which are plentiful, and may be seen in numbers towards the end of summer flying over almost any pond. The pretty Demoiselles, seeming almost fairy-like in their delicate grace, the yellow-bodied *Libellula depressa*, and many others, may be seen hawking for prey, passing from place to place with the most wonderful rapidity, and ever and anon capturing a hapless insect, which is devoured almost as soon as fairly seized.

As is the case with many of the most brightly-coloured insects, the tints of the dragon-flies, brilliant as they are during life, fade and often entirely disappear in death. A collection of dragon-flies, therefore, can give no idea of the beauty of the living insects, the reds and greens and blues all merging into the one uniform tint of brown. No method of preventing this alteration has yet been discovered, and it would seem that the only way to do so would be to take the insect to pieces, carefully paint the interior, and join the fragments again with cement. Even this process, however, would probably prove unsatisfactory, and the



Libellula depressa.

dried specimens would present a very different appearance to the living insects as they sport in the sunshine.

Many interesting foreign insects, such as the Antlion and the Termite, or, as it is wrongly termed, the White Ant, belong to this order; but, as our space is limited, we must pass them by and turn to another of our British *Neuroptera*, namely, the Lacewing Fly *(Chrysopa vulgaris).*

This exquisite insect may often be seen flying in the dusk during the summer months, looking on the wing very much like a small white moth. When captured, however, it is seen to be of a pale green colour, with iridescent wings, various tints playing over them by turns.

The eye of the lacewing fly is a truly wonderful object, far surpassing both in brilliancy and depth of colour that of any other insect.

So graceful and delicate an insect would secure unmingled admiration were it not for one most unpleasant property it possesses, *i.e.*, the power of exuding a liquid of the most nauseous and penetrating odour that can possibly be imagined. A mere touch is sufficient to bring out this evil perfume, and even repeated ablutions will hardly lessen its potency, several days sometimes elapsing before its traces finally disappear.

The lacewing is one of our many unrecognised insect benefactors, the larva uniting with the various ladybirds in their attacks on the destructive aphides. It has the peculiarity of clothing itself with the skins of its victims, after sucking their juices, in such a manner that its form is almost entirely concealed. Its ravages are, however, not entirely confined to those mischievous little insects, for it will even devour its own comrades, should they happen to meet with one another.

The ova are deposited in a somewhat remarkable manner, each egg being fastened upon a separate footstalk, half an inch or so in length. These footstalks are formed from a viscous fluid secreted by the parent insect, a minute drop being exuded upon a twig or some other object, and the body suddenly withdrawn. The gummy fluid is thus drawn out into a thread, upon the extremity of which the egg is placed.

A number of these eggs are always placed together, and present a very curious appearance, closely resembling the capsules of various mosses. Indeed, by many authors they have been considered as mosses, and described and figured accordingly.

No. X.—THE TRICHOPTERA AND HYMENOPTERA.

THE *Trichoptera—i.e.*, 'hairy winged' insects, were until comparatively of late years supposed to form part of the *Neuroptera*, to which they certainly bear a close resemblance.

The wings are four in number, generally tolerably equal in size, and, as a rule, more or less profusely covered with hair. The second pair are folded beneath the upper when the insect is at rest. The mouth, in the perfect insect, is not developed, so that no nourishment can be taken, just as is the case with the common May-fly.

The *Trichoptera* include those insects which are popularly known as Caddis-flies, and which are so dear to anglers, both in the larval and perfect stages of their existence.

In their life-history, as well as in the general details of their structure, the caddis-flies bear a strong resemblance to the dragon-flies, passing the earlier portion of their life beneath the surface of the water. Unlike those insects, however, they construct for themselves habitations, or 'cases' in which to pass their larval existence, these differing in structure according to the species of the insect, and the nature of its surroundings.

As a rule, these cases are more or less cylindrical, and are formed of all manner of substances, leaves, sand, small stones, sticks, etc., being amongst those usually employed. The grub is, however, by no means particular in its choice, and will make use of any suitable object which may fall in its way.

Two small hooks may be noticed at the extremity of the body, by the agency of which the larva is enabled to retain its position in the case.

Towards the middle of May these cases may be found in great abundance in any suitable pool, a single sweep with a net often bringing up several double handfuls. A few weeks later on the perfect insects appear, and may be found in plenty in the neighbourhood of water. Several British species are known, but lack of space prevents me from describing them, and forces me to proceed at once to the next order of insects, namely, the *Hymenoptera*, or 'membranous winged' insects.

This can by no means be considered as a happy title, answering equally well to almost any of the great groups of insects. There is, however, no difficulty in distinguishing a hymenopterous insect at first sight, the anterior and posterior wings being united when in use by a series of small hooks running along part of the upper edge of the lower wing, and fitting into a fold in the lower edge of the upper wing.

These hooks differ in form to a very considerable degree in the various families of the *Hymenoptera*, those from the wing of a wasp, for instance, being very distinct from those taken from a bee or ichneumon. So much is this the case, indeed, that an experienced entomologist can detect, by the examination of a single hook, to which family of the order its owner belonged.

The second pair of wings are always much smaller than the first, and are intersected by fewer veins. The head is furnished with a pair of horny jaws, and also with a fleshy tongue, lying between and protected by them. The abdomen of the female is provided with an ovipositor formed of several parts, modified in some groups into a poison-bearing sting. The pupa is invariably quiescent, as is also the larva, except in the case of the Saw-flies.

The *Hymenoptera* are usually divided into two chief sections, viz., the *Terebrantia*, or 'Borers,' and the *Aculeata*, or 'Sting-bearers.'

The first subdivision of the leading group includes the Saw-flies and Gall-flies, in which the base of the abdomen is attached to the thorax by the whole of its diameter, the larvæ feeding upon vegetable substances of various kinds, and being furnished with horny mandibles and a well-developed mouth.

The saw-flies bear the appropriate title of *Tenthredinidæ*, an appellation formed from a Greek word signifying to gnaw, or nibble. The wings of these insects are large, the nervures forming several distinct cells; the abdomen is not connected with the thorax by means of a footstalk, and is provided, in the female, with the curious apparatus from which the name 'Saw-fly' is derived.

This consists of a couple of flat horny plates, placed side by side on the under surface of the extremity of the abdomen. These two plates constitute the saws, one edge being set with elaborately formed teeth, while the other is strengthened by a thick horny plate. In fact, the structure of the instrument almost exactly resembles that of our own tenon saws.

These saws slide into grooves, and are so constructed that one is withdrawn while the other is thrust forward. By their agency, a resting place is prepared for the eggs, a groove being cut in a leaf, or twig, an egg placed therein by the ovipositor, and fastened by a small drop of a glutinous fluid secreted by the insect.

The larvæ of the saw-flies differ from those of the other groups of *Hymenoptera* in possessing limbs, and passing an active existence. At first sight they might easily be mistaken for the caterpillars of lepidopterous insects, the general structure being of very much the same nature. Their true character, however, may be easily ascertained by an examination of the claspers, or false legs, which are never more than ten in number in the larvæ of the *Lepidoptera*, while the grubs of saw-flies possess from twelve to sixteen of these members.

Perhaps the most abundant, and certainly the most destructive of our British saw-flies, the Turnip-fly or Nigger (*Athalia spinarum*), must not be passed by without a few words of notice.

This terrible pest to the agriculturist is, happily, rather capricious in its visits, being seldom common in the same district during two successive years. When it does make its appearance, however, the turnip-crop vanishes as though before a swarm of locusts, scarcely a plant being spared by the voracious grubs.

Another destructive saw-fly is that known as *Nematus grossulariæ*, the larva of which wreaks considerable havoc upon the foliage of gooseberry bushes.

The last of our British saw-flies which can be mentioned in these pages is one that by few except practical entomologists would be taken for a saw-fly at all, the form and colouring being so like those of a hornet, that the mistake is little to be wondered at.

This insect is scientifically known as *Sirex gigas*, and is usually tolerably plentiful in pine woods, upon the solid wood of which the larva feeds.

In this insect the saws are modified into a sharp and powerful boring implement, consisting of three portions, the two outer parts acting as sheaths to the inner, or actual piercing tool. This weapon attains to a con-

Sirex gigas.

siderable size, being, in an ordinary female *sirex*, little short of an inch in length.

We now come to a very remarkable group of *Hymenoptera*, namely, the *Cynipidæ*, or Gall-flies.

These insects, usually of very small dimensions, produce the excrescences upon various trees and plants which are generally known as Galls, and which form a habitation for the larva. These galls are caused as follows.

The female insect makes a small puncture in a leaf or twig, and deposits therein an egg, and a small drop of an irritant fluid. This acts in some strange manner upon the juices of the plant, causing a swelling to form, in the middle of which lies the egg. This in due time hatches, and the young grub finds itself provided both with food and dwelling.

It is a curious fact that the eggs, both of the saw-flies and gall-flies, increase in size to a considerable extent before the larvæ are hatched.

A vast number of gall-flies are already known to science, and others are annually being discovered. There are, however, but few students of the group, the small size and obscure habits of the insects rendering the study of their habits a matter of the greatest difficulty.

As a general rule, one larva only inhabits each gall. With some species, however, the gall is composed of a number of cells, each containing a separate grub.

One of the most familiar of all the galls is that popularly known as the 'Oak-apple,' and which is produced by the dull-coloured little *Cynips Kollari*. Scarcely an oak tree or bush but bears a quantity of these curious objects, which are often used by way of ornament in the construction of various fancy articles.

Some of the gall-flies are double-brooded, and present a very remarkable phenomenon, the two generations being to all appearance totally distinct from one another, and having until very lately been considered as representing separate species. Recent investigators, however, have found that, different as they appear, they are in reality only alternate broods of the same insect.

The *Ichneumonidæ* comprise a vast number of insects, whose life-history is of the most singularly interesting nature.

These creatures are parasitic upon other insects, the larvæ usually spending their existence within the body of their victim.

Therein an egg is deposited by the parent insect, the young larva almost immediately hatching, and commencing to prey upon the body of its involuntary host. Instinctively avoiding the vital organs, it continues to feed upon the fatty portions until it attains its full development, when its victim succumbs to its attacks, almost the whole of the interior having been eaten away.

In some cases, a single egg only is deposited in the body of the larva; in others, the parasites may be reckoned by the hundred. In one instance, over one thousand specimens of a small ichneumon-fly were bred from a single larva of the Wood Leopard Moth (*Zeuzera æsculi*).

So vast is the number of insects composing this group that we cannot do more than glance at the history of more than two or three species, the first of which shall be the little insect known as *Microgaster glomeratus.*

This ichneumon must be ranked in the category of our insect benefactors, preying, as it does, upon the larvæ of the well-known 'white' butterflies, which are so terribly destructive to the cabbage crops. In some districts, indeed, the larger and more destructive of these insects has been almost annihilated by its tiny foe, and scarcely a single specimen is now to be seen where the butterfly formerly existed in thousands.

When full-fed, the parasites leave the body of their victim, and construct small cocoons of yellow silk, in which to pass their pupal existence. These cocoons may be seen in great numbers upon the fences bordering any field of cabbage, and are usually considered by ignorant persons as the 'caterpillar's eggs,' and destroyed accordingly.

The only other ichneumons to which space, or rather, the want of it, permits us to allude, are the curious little *Pezomachi*, which are parasitic upon the eggs of various spiders. These insects are without wings, and so strongly resemble ants that a close examination is required to identify them.

The next great group is known as the *Aculeata*, or Sting-bearers, and comprises several families, the first of which consists of the ants. These, although represented in this country by comparatively few species, abound in tropical lands to an almost incredible degree.

These insects may be divided into two groups, namely, the social and the solitary ants. Very few of the latter are found in this country, and the interest centres almost entirely upon the social species.

These ants, like the bees and wasps, apparently consist of three sexes, namely, the male, the female, and the worker. It has of late years been discovered, however, that two sexes only in reality exist, the workers being nothing more than undeveloped females. One great proof of this fact lies in the possession by the workers of stings, which, in all the *Aculeata*, are found in the female insects alone.

In these ants, the perfect male and female only are furnished with wings, the workers being unprovided with those organs. Even the perfect insects bear them for a short time only, making a single flight into the air, where they choose their mates, and snapping them off close to the body immediately upon descending to the earth.

It has been well remarked by Sir John Lubbock, that, if the anthropoid apes approach most closely to man in bodily form, the ants, small and insignificant though they are, most nearly resemble him in point of intellect. And when we come to examine the wonderful details of their life-history, of the organisation and regularity found in every part of the nest, of the division of labour, each individual insect having its appointed work apportioned to it, and of the manifold ways in which these insects seem almost to imitate man himself, we cannot but wonder that creatures so small, possessed neither of speech nor, to all appearance, of reasoning powers, should yet be enabled to perform feats requiring such surprising intelligence.

Many human institutions are found reproduced amongst these wonderful insects. Standing armies are kept up, and divided into corps, battalions, regiments, and companies, all under the command of regular officers, just as is the case with our own troops. The warriors go through the most surprising evolutions with an order and regularity worthy of the most highly-drilled soldiers in existence. Slaves are captured from other nests, and perform the duties of domestic servants and nurses. Several species of ants even bury their dead, and in numberless other ways prove the advanced state of their intellectual powers.

Volumes might easily be filled with descriptions merely of the habits of these wonderful little creatures, and we cannot but regret that lack of space obliges us to proceed to the next division of the *Hymenoptera,* namely, the *Diploptera*, or insects whose lower wings are folded longitudinally when not in use. This group comprises the insects popularly known as Wasps.

As is the case with the ants, there are solitary and social species, the former consisting of perfect male and female insects only, while in the latter undeveloped females, or workers are found, and play a very important part in the economy of the hives. These workers, however, are possessed of wings.

Very few of the Solitary wasps inhabit Great Britain, chief among them, perhaps, being the curious *Odynerus melanocephalus*, which hollows out the dead twigs of rose trees, etc., and constructs therein a series of cells, in each of which it deposits an egg, and a small caterpillar or two by way of food to the future grub.

The British Social wasps, eight in number, all belong to the genus *Vespa*, and construct nests of great beauty from a paper-like substance, formed by masticating small fragments of wood. With some wasps these nests are built underground, or in a hollow tree, or other suitable locality; others construct pensile habitations, usually from the branch of some tree or bush. To the first class belongs the common wasp, while the little known tree-wasp and Norwegian wasp are included in the latter group.

In the British Museum may be seen a very curious series of nests of the common wasp, built by insects in the possession of the late Mr. S. Stone.

The Bees are included in the *Anthophila*, or 'Flower-lovers,' a family sometimes known as the *Mellifera*, or 'Honey-bearers.' These insects may also be divided into two groups, the social and solitary, the workers being only found in the insects of the former division.

The life-history of the most familiar species, viz., the common Hive Bee, is too well-known to need any description in these pages, and we will therefore conclude this paper with a short account of one or two of our less understood bees.

The most familiar of the wild social bees are those which are commonly called Humble Bees. Some make their nests in holes in the ground, some upon the ground, and others in rocky crevices.

The first-mentioned are the most plentiful. They take possession of the deserted burrow of a rat or field-mouse, enlarge it as required, and by degrees produce a numerous brood. The cells are not hexagonal, and formed into combs like those of the hive bee, but are oval, and heaped together without any attempt at arrangement. This is the case with all the humble bees.

The Carder Bee (*Bombus muscorum*) is remarkable for the curious manner in which the nest is constructed, the insect collecting moss, grass, etc., and carefully drawing them through her legs, in much the same manner as wool is carded. With the material thus prepared, she builds a kind of dome-like structure upon the ground, carefully framing it so as to harmonize with the surrounding objects. Within this are constructed a series of oval cells, placed a tirregular intervals.

This is a very common species, and, if approached with care, may be examined while at work, and the structure of the nest inspected.

The Red-hipped, or Stone Humble-bee (*Bombus lapidarius*), is a very familiar species, and derives the second of its popular titles from the situation of its nest, which is generally placed beneath a heap of stones. Should such a position be unattainable, the nest is usually constructed in a hole in a bank, or other convenient locality.

In all, about eighteen or twenty species of humble-bees are found in Great Britain, many of this number, however, being extremely scarce.

No. XI.—THE LEPIDOPTERA.

Part I.

THE butterflies and moths form the order scientifically termed *Lepidoptera*, which is placed next upon the list. This name signifies 'scale-winged,' and is applied to the insects of the group on account of the scales with which both the upper and under surfaces of the wings are closely covered. The structure of these scales has already been explained in the third of this series of papers.

The most important of the remaining characteristics of the group is found in the structure of the mouth, which is formed for suction only. The mandibles, or outer jaws, are rudimentary only, and scarcely visible without close examination. The maxillæ, or inner jaws, however, are developed to a very great extent, and form a long trunk, or proboscis, through which liquids can be sucked into the mouth. When not in use, the proboscis is coiled away beneath the head.

The Lepidoptera are generally considered to form two natural groups, known respectively as butterflies and moths, the members of the former being distinguished from those of the latter by their clubbed antennæ, by the form of the body, and by the position of the wings when the insect is at rest.

As far as the British Lepidoptera are concerned, these distinctions are amply sufficient to separate the insects of the one group from those of the other, the clubbed antennæ alone being a sufficiently marked characteristic.

But, when we come to examine the insects of other parts of the world, we find that these points of difference no longer hold good. Many exotic moths, for instance, possess antennæ far more strongly and distinctly clubbed than those of most butterflies, while those organs in several genera of the latter insects are as plain as is usually the case with the moths. The form of the body, too, can no longer be relied upon as a distinguishing feature, and there is really no characteristic which can be decided upon to invariably separate the insects of the two groups. It is, therefore, considered by our leading authorities that the Lepidoptera form one large group only, divided into a number of smaller families. In the present paper, however, as the Lepidoptera of our own country can alone be described, we shall still consider the insects as being divided into two great sections.

The butterflies are divided into five families, which are distinguished chiefly by the veining of the wings, the form of the antennæ, and, more particularly, by the development of the legs. For, in many butterflies, the first pair of these organs are so short and imperfect as to be quite unsuitable for the purpose of walking, and it is even doubtful whether they fulfil any functions whatever. So small are they, indeed, that to a careless observer they would be totally invisible. The structure of both the larva and pupa are also taken into account.

The first of these five groups comprises the *Papilionidæ*, the members of which, although, with one exception, few and insignificant in this country, attain to great size and beauty in tropical lands.

The beautiful Swallow-tail Butterfly is our one representative of tropical magnificence, and even this solitary example seems likely before very long to become extinct as far as Great Britain is concerned. It is found in marshy land only, and is almost entirely confined to the fens of Cambridgeshire, Norfolk, and Huntingdonshire. In some parts of these counties it is still found in tolerable plenty, although the draining of the marsh-land, combined with the attacks of insect collectors, is rapidly diminishing its numbers.

The most familiar insects of this family are the 'White' butterflies, so plentiful in every part of the country from early spring to late autumn. These butterflies are the parents of the caterpillars which devastate our cabbage-crops, and which are in consequence held in the greatest detestation by the agriculturist. Indeed, were it not for their untiring foe, the little Ichneumon-fly (*Microgaster*), it is doubtful whether a single cabbage-plant would be free from their attacks. The labours of this little fly, indeed, deserve our warmest gratitude, for, thanks to its ravages, the most important of these butterflies, namely, the Large Cabbage White, is now comparatively scarce, hardly a single specimen being now seen where formerly the insect existed in thousands.

As an instance of the multitudes in which the larvæ of this butterfly have sometimes appeared, the following extract from Coleman's 'British Butterflies' may be of interest:—

'A note in the "Zoologist," p. 4547, by the Rev. Arthur Hussey, gives us the following:—"For the last two summers many of the gardens of this village have been infested by caterpillars to such an extent that the cabbages have been utterly destroyed." When the time for changing to the chrysalis state arrived, the surrounding buildings presented a curious appearance, being marked with long lines of the insects travelling up the walls in search of a suitable place of shelter for undergoing their transformation. A great number of caterpillars took refuge in a malthouse, from which they could not escape as butterflies, the result being that for several weeks the maltster swept up daily many hundreds of the dead insects.'

In the same work an instance is given of the valuable services rendered to man by the *Microgaster* in destroying these larvæ.

'In 1842,' says Mr. Coleman, 'a vast flight of white butterflies came over from the Continent to the coast about Dover, and, spreading inland from thence, did an immense amount of damage to the kitchen gardens; but so effectually did the ichneumon flies do their work, that an exceedingly small proportion of the caterpillars resulting from this flock of immigrants went into the chrysalis state, nearly all perishing just before the period of change.'

Various small birds also contribute largely to the destruction of these caterpillars, which they devour in great numbers.

The eggs of this butterfly are very curious objects, being shaped something like skittles, each egg standing upright, and deposited in little clusters of ten or twelve. When placed under the microscope, these eggs are seen to be covered with a raised pattern, a number of bold ribs running from top to bottom, while a series of raised transverse lines pass over both ribs and interstices. These eggs may generally be found by examining the leaves of the cabbages in May and August, the butterfly being double-brooded.

The chrysalis is suspended by a thread round the middle to any convenient object, such as a post or wall.

The Smaller White Butterfly, now by far the more abundant of the two insects, is, in one way, even more destructive than the preceding insect, for the larva bores into and devours the very heart of the cabbage, while that of the larger white is contented with the outer leaves. Consequently, it is not so readily detected and destroyed, being concealed from the view of most of its enemies.

To this group also belongs the beautiful Brimstone Butterfly, which is so common throughout the year in most parts of the country.

The next family, that of the *Nymphalidæ*, comprises a considerable number of species, comparatively few of which, however, possess special interest to any but an entomologist. Among these exceptions, however, we may mention the insects of the genus *Vanessa*, which includes the beautiful Peacock and Scarlet Admiral Butterflies, the Tortoiseshell, and some others.

Most of the Vanessas feed, while in the larval state, upon the leaves of the common stinging-nettle, which they roll up in order to form a hiding-place where they may be concealed from the view of their enemies. The chrysalis is always suspended by the tail, and is, in all the species of the genus, a very beautiful object, being plentifully adorned with gilded spots, looking like so many patches of gold leaf.

These butterflies emerge from the chrysalis at the beginning of autumn, and pass the winter, in a state of torpor, in some sheltered retreat. Old barns, church towers, hollow trees, etc., are usually resorted to by numbers of hibernating butterflies, which remain motionless until the warmer days of spring tempt them once more to exercise their wings.

But their demeanour is then entirely changed. During the few weeks which intervened between their release from the pupal shell and their retreat to their winter's hiding-place, their occupation was solely that of seeking amusement, or extracting the sweet juices from various honey-bearing flowers. But as soon as spring arrives, they enter upon the serious business of their lives, viz., that of providing for a future progeny, and the female butterflies, worn and battered in their passage through life, may then be seen flitting slowly along the roadsides in search of some convenient spot in which to deposit their eggs. This done, their work is over, and they seldom survive the operation for more than a few hours.

The Scarlet Admiral Butterfly is perhaps the most generally known of these insects, its broad black wings, with their stripes of brightest red, being familiar to almost every resident in the country. It may sometimes be seen in countless numbers, resting upon the blossoms of the ivy-bushes on a sunny morning, in company with others of the same genus. In such a case, the effect of the mass of black and crimson wings, slowly opening and closing as their possessors regale upon the sweet juices, is almost magical.

Scarlet Admiral.

One of the families of butterflies, the *Erycinidæ*, although numbering many members in foreign countries, possesses only a single representative in Great Britain. This butterfly, quite a small species, bears the somewhat lengthy title of 'Duke of Burgundy Fritillary.' It is a curious fact that the males of all the insects of the family have four fully-developed legs only, while the females possess the normal number of six.

Remarkable for the bright, metallic tinting of their wings, the Blues and Coppers are included in the family of the *Lycænidæ.* In these all six legs are fully developed in both sexes. In common with the Skipper Butterflies (*Hesperidæ*), these do not possess any great general interest, and we will therefore proceed to the second great section of the *Lepidoptera*, which includes those insects popularly known as Moths.

In these insects there is far more variety in shape and size, at least as far as our British species are concerned, than in the butterflies. Indeed, the antennæ alone of the insects comprising the group are sufficiently diverse in form to have earned the title of *Heterocera*, *i e.*, 'varied horned,' for the section.

The first family of these insects, the *Sphingidæ*, consists of the large Hawk-moths, which form a very distinct group. The scientific title was derived from the fanciful likeness supposed to exist between the larvæ of these moths and the Egyptian sphinx.

Although this resemblance is not very striking to an ordinary eye, the larvæ are yet very interesting creatures, furnishing, on account of their large size, very suitable objects in which to watch the life-history of the Lepidoptera. They nearly all possess upon the upper surface of the twelfth segment of the body a curious curved horn, the object of which is altogether unknown. That it cannot be intended as a weapon either of defence or offence is evident enough, for the substance of which it is composed is not sufficiently firm to allow it to cause the slightest harm, even to the most sensitive skin.

The popular term of 'Hawk' moth is appropriate enough, for, both in form and flight, these insects strongly resemble the birds after which they are named. With such remarkable speed, indeed, do they pass through the air that the eye cannot follow their movements, the insects seeming to vanish and reappear as if by magic. Most of them are nocturnal in their habits, and may be seen hovering over flowers at dusk.

Our largest British moth, the Death's-head Hawk, is the most prominent member of this family, and attains to a very considerable size, a large specimen being often as much as five inches in expanse of wing. The caterpillar, too, is of very great size, and is found in potato-fields, that plant constituting its food.

It is, however, often found upon the jessamine, and, as a rule, a caterpillar which is found upon jessamine will not eat potato, and *vice versa.*

Owing to the curious skull-like mark upon the thorax, from which the insect derives its name, the Death's-head Moth has been, and still is, regarded with superstitious views by the uneducated portion of the community. Its advent is thought to presage death or misfortune, and the insect is consequently regarded with great awe and terror. Its peculiar faculty of uttering a shrill squeak when alarmed is almost invariably considered as a proof of its super natural attributes.

The method in which this sound is produced has never been satisfactorily cleared up. Some observers have thought that it is caused by the friction of the palpi with the proboscis, others by the movement of the head against the thorax, and so on. Neither of these theories, however, will hold good when we take into consideration the fact that the sound is produced, not by the perfect insect alone, but also by the larva, and, more curious still, the pupa. The *modus operandi*, therefore, of producing the squeak employed by the insect during the various stages of its existence, has still to be determined.

Larva of Privet Hawk-moth.

It is currently reported in the south of France, where the insect is abundant, that the death's-head moth is in the habit of making its way into the beehives in order to feast upon the honey contained in the cells.

Want of space permits us to mention one more moth of the hawk tribe only, and we will therefore select the aptly-named Humming-bird Hawk-moth. This insect so closely resembles, both in form and habits, the little bird whose name it bears, that even residents in the tropics, who have been acquainted with humming-birds from their earliest childhood, have been deceived by the wonderful likeness borne to those birds by the hawk-moths. This resemblance is still further increased by the habit of the hawk-moth of hovering over the flower while extracting its juices, the humming-birds themselves feeding in exactly the same manner.

This is one of the swiftest of the tribe when upon the wing, vanishing and re-appearing with the rapidity of lightning. It is common in most parts of the country, and differs from nearly all the members of the family in that it flies by day instead of by night.

Next to the hawk-moths most authors place the *Sesiidæ*, or Clearwings, insects whose wings are only partly covered with scales. One of our leading authorities, however, considers that they are out of place in their present position, and removes them to a totally different group.

The greater number of these clearwing-moths bear so close a resemblance to bees, wasps, gnats, etc., as to deceive any but an experienced entomologist. The larvæ are all 'internal' feeders, in other words, they live inside the roots, stems, twigs, or even the solid wood itself, of various plants and trees.

The next family, the *Zeuzeridæ*, is a very small one in this country, consisting of two species only. Both are wood-boring insects while in the larval state, the more familiar of the two being especially interesting.

This is the well-known Goat-moth (*Cossus ligniperda*), so-called from the odour proceeding from the burrows of the larva, which somewhat resembles the scent of the he-goat The perfect insect, although common, is not very often seen, being of a very sluggish temperament, and seldom stirring forth until after dark.

The larva feeds upon the solid wood of various trees, such as the oak and the willow, frequently causing great damage by its network of burrows. Its jaws are admirably fitted for their duties, for they are so powerful that scarcely any substance short of iron or tin will withstand their attacks. These caterpillars have even been known to perforate sheet-lead, so it may be easily imagined how rapidly the wood upon which they feed is cut away by their powerful mandibles.

By a curious provision, the pupa of this insect, as well as that of its congener, is able to travel along its tunnels with considerable speed. The edge of each segment is furnished with a row of little hooks, by the aid of which the pupa can wriggle itself along almost as rapidly as when in the caterpillar state. Just before the perfect insect emerges, the pupa travels in this manner to the mouth of the tunnel, in order that the moth may not be incommoded by want of space.

The development of this insect extends over a considerable period of time, the larva alone requiring four years in order to complete its growth. The egg from which it springs is deposited by the parent insect deeply in the bark of the tree by means of her long ovipositor, the little caterpillar travelling into the wood immediately it is hatched. From the time it is hatched until it attains the pupal condition, it never seems to cease feeding. Consequently, a tree attacked by these larvæ is so weakened by the combined attacks of the caterpillars, sixty or seventy of which are often found in the same trunk, that it dies as surely as if the woodman's axe had laid it low. So plentiful and widely-spread is the insect, that it is hardly possible to find a row of willow-trees several of which do not exhibit signs of the presence of the destroyer, while many a noble tree is so riddled by the tunnels that scarcely a cubic inch of sound wood is to be found in the trunk.

No. XII.—THE LEPIDOPTERA.

Part II.

PASSING by several families of moths, we come to the Tiger Moth, an insect more commonly seen in its larval than in its perfect state. It is hardly possible to walk along a country lane in the spring without noticing a colony or two of these caterpillars feeding upon the nettles and other plants growing by the roadside. These larvæ are popularly known as 'Woolly Bears,' owing to the quantity of long hair with which their bodies are thickly covered.

The perfect insect, although very plentiful, is comparatively seldom seen, owing to its retiring habits. It cannot, however, resist the mysterious attraction which artificial light appears to exercise towards many insects, and may often be noticed upon a dark night fluttering wildly around the street lamps, or resting peacefully upon the panes which enclose the source of attraction. It is a very handsome insect, the upper wings being of a rich velvety-brown, intersected with white markings, while the lower pair are generally red, variegated with large blue-black blotches of variable number, size, and form. It would be impossible, however, to write a description which would apply to all specimens of the moth, as the colour and markings vary to a most wonderful extent. Sometimes a tiger moth will be found in which all four wings are of an uniform brown-black hue, scarcely a trace of the ordinary markings being visible. In other cases a creamy white predominates to an almost equal extent, while in less aberrant specimens the form and size of the usual markings vary to an almost inconceivable degree. It would, indeed, be by no means a difficult task to fill a case with a number of examples of this moth, no two of which should exactly resemble one another.

Allied to the tiger moth, although placed in a different family, the Gold-tail Moth next claims our attention. This is a singularly pretty insect, the wings, head, thorax, and the greater part of the body being of a pure satiny-white. The extremity of the abdomen is adorned with a large tuft of golden-yellow hair, from which the insect derives its popular name.

The chief interest of the gold-tail moth centres in the caterpillar, whose body is thickly covered with hairs endowed with a peculiarly poisonous property. If the creature be handled, a number of these hairs are sure to enter the skin, and will leave unpleasant reminiscences of their presence for some little time. At first an intolerable itching is felt in those parts which have been pierced by the poison-bearing hairs. This is speedily followed by the swelling of the affected parts, which sometimes takes place to such an extent that the victim appears as if a number of large potatoes had been introduced beneath his skin.

Some persons are far more severely affected by these 'urticating' hairs, as they are scientifically termed, than others, while a favoured few are entirely unharmed by them. They are not peculiar to the gold-tail larva, for the caterpillars of many other allied insects are similarly endowed, although in a lesser degree.

The larva is a very handsome one, the ground-colour being black, while two interrupted vermilion stripes run longitudinally for the entire length of the body. It feeds principally upon the whitethorn. The female moth has a curious habit of covering her eggs with a kind of thatch, formed from the tuft of golden hair at the extremity of her body, which she tears off for the purpose.

In the warm, sunny days of August and September a small, brown moth may be seen dashing wildly to and fro with a curiously erratic flight, changing the direction of its course almost every other moment. Even in the smoky squares of London this active little creature may be noticed, revelling in the warm rays of the sunshine.

This is the male Vapourer Moth, really a very pretty insect, the wings being of a rich chestnut-brown, with a white crescent-shaped spot in the anal angle. No one except an entomologist, however, would recognise the female vapourer for a moth at all, for she is a clumsy, grub-like creature, almost entirely destitute of wings, and bearing no resemblance whatever to her active and handsome mate. So large and ungainly is her body in proportion to the size of her limbs that she is quite unable to move a single step, and spends the whole of her existence clinging to the web which contained the pupa from which she emerged. Upon this web she lays her eggs, arranging them in long rows with great regularity, and dying as soon as her task is completed.

It is a curious fact that the eggs of the vapourer moth do not hatch simultaneously, as is the case with those of insects in general, but do so in detachments, a period of eight or ten weeks elapsing between the time in which the first larva makes its appearance and that in which the last of the brood leaves the egg-shell. It is, therefore, by no means unusual to find the insect in all the stages of its development at the same time, a single tree furnishing egg, larva, and pupa, while the perfect insect may be seen fluttering in the neighbourhood.

This is also the case with an allied species, the Oak-eggar Moth, and I have upon more than one occasion had the insect in all its stages in my breeding cages at one and the same time.

The vapourer moth is a most ubiquitous creature, the larva feeding upon the foliage of almost any tree or shrub with equal avidity. Fruit trees often suffer greatly from its attacks, and were it not for the labours of the various insect-eating birds, we should probably have to rank the insect among the greatest foes to our kitchen-gardens and orchards.

The Lackey Moth is chiefly worthy of notice on account of the manner in which the female deposits her eggs, for she places them in the neatest possible rings round the twigs of apple-trees.

We now come to the great group of Geometers—*i.e.*, 'step-measurers'—which are so called on account of the peculiar method of walking employed by the caterpillars.

It will be remembered that, as a general rule, the larvæ of the lepidoptera are provided with ten false legs, or claspers, in addition to the six true limbs which are possessed by every insect. In the geometers, however, four only of these claspers are found, these being placed at the extremity of the body. Owing to this structure, the larvæ of these moths are obliged to proceed in a very peculiar way, and do so in the following manner :—

Clinging tightly to the twig upon which they are resting with the true legs, they draw the body into a loop, so that the anal claspers are brought into close proximity to the head and legs. A firm grasp is then taken with the claspers, and the body stretched out to its full length, when a fresh hold is taken with the true legs. The body is again drawn up as before, and the process repeated as often as required. In consequence of this habit, the larvæ are often called 'Loopers.'

Nearly all the geometer larvæ are protected from the attacks of birds and other enemies by the wonderful resemblance which they bear to the twigs of the food-plant. Many of them have projections upon various parts of the body which are so wonderfully similar in appearance to the young buds that even the most practised eye will often fail to distinguish the larva from the twig upon which it is resting. The attitude assumed in repose aids them greatly in their resemblance to surrounding objects, as the body is almost invariably stretched straight out at an angle from the branch to which the caterpillar is clinging, the claspers alone sustaining the entire weight of the body.

In order to do this, the muscular power must be simply marvellous. One of the most trying feats in gymnastic exercises is to hold the body at right angles to a perpendicular bar by the grasp of the hands alone, and not even the most powerful and accomplished performer can remain in that position for more than a few seconds. Yet, with these caterpillars, this apparently strained and unnatural position seems to be the normal attitude of repose, and can be sustained for hours without the slightest inconvenience.

The geometers comprise a very large number of insects, even in this country, very few of which, however, can be mentioned in this article.

One of these is the very plentiful Gooseberry, Currant, or Magpie Moth, the larva of which often appears in such numbers as to cause very considerable damage to the fruit bushes. This destructive caterpillar may be easily recognised by the cream-coloured body, and the longitudinal reddish-orange stripe running below the spiracles. It is a curious fact that neither toads nor insect-eating birds will touch this caterpillar, which seems to be protected by some flavour which is distasteful to its natural enemies.

Like the tiger moth, the magpie moth is extremely subject to variation in colour and marking, scarcely two specimens being precisely similar. The ground-colour of the wings is generally a creamy white, while a number of black blotches of uncertain size and form are distributed over their surface. There is generally a bent transverse band of yellow beyond the middle of the fore-wings, their bases being also adorned with a yellow blotch. Sometimes, however, specimens will be found in which the black markings usurp almost the whole of the wings, while in other examples their position is only faintly indicated, white being the predominant hue.

A far more destructive insect now claims our attention, fruit trees of various kinds suffering greatly from its ravages. This is the Winter Moth (*Cheimatobia brumata*), which, unlike moths in general, makes its appearance upon the wing at a time when insect life is conspicuous by its absence.

Upon any mild evening in December or January, we may see a number of delicate, light-brown moths fluttering round every lamp-post, in their vain attempts to discover the mystery of the flame. These are the male winter moths, the female being possessed of only the merest rudiments of wings. In general form, indeed, she is not unlike a spider, and is able to run about the tree-trunks with considerable activity.

Her eggs are deposited in the crevices of the bark of various fruit trees, such as the apple, pear, plum, quince, etc., the young larvæ hatching in early spring, and at once making their way into the, as yet, unopened buds. At this period of their existence vast numbers are destroyed by titmice and other small birds, which, however, according to the late Mr. E. Newman, do not appear to discriminate with sufficient care between the sound and the damaged buds. When the leaves are a little more advanced, the grubs emerge from their domiciles, and spin two or three together, in order to form a refuge in which they are concealed from the sight of their numerous foes, and which they only partially leave when engaged in feeding. In May they are full-fed, and then descend to the ground in order to undergo their change to the pupal condition.

In order to rid the orchards as far as possible of the pest, Mr. Newman recommends that each tree should be painted with a mixture of Stockholm tar and cart-grease, laid on in a circular belt. This composition does not injure the tree, and captures the female moths in great numbers as they ascend the trunks in order to deposit their eggs. The application must be renewed once in four or five days or so, and also after a frosty night, which causes it to harden, and so renders it useless.

An inspection of the trees after dark by the aid of a lantern is also recommended, in order that any moths which had taken up their abode in the branches before the sticky mixture was applied might be detected and killed before they had an opportunity of depositing their eggs.

Yet, even if every precaution be taken, more or less damage is sure to be caused in every orchard by this destructive moth, which we must certainly rank as one of the most mischievous of our insect foes.

Omitting, from lack of space, the next group of moths, we come to the large division of the *Noctuæ*, or Owl Moths, so called because they fly almost exclusively by night. Of these, more than three hundred species inhabit Great Britain, while the group is very largely represented in other parts of the world.

One of the earlier species of these, the Peach-blossom, must be mentioned merely for the sake of its marvellous beauty, each of the upper wings being adorned with five pink spots of the exact form and hue of the petals of the peach. The ground-colour is a rich olive-brown. A prettier insect could hardly be imagined, and, as far as the British *noctuæ* are concerned, the peach-blossom certainly bears away the palm in point of beauty. In some places it is fairly plentiful, while in others it is seldom or never seen.

To this group belong also the destructive Turnip Moth (*Agrotis segetum*), and the equally mischievous Cabbage Moth (*Mamestra brassicæ*), both of which are among the direst foes of the agriculturist. The former is perhaps the more to be dreaded of the two, as the ravages of the larva take place beneath the ground, where its presence is not easily to be detected. It does not hibernate, or pass the winter in a state of torpid inaction, but continues to feed as before.

But very few of the *noctuæ* are of interest to any but professed entomologists, their habits and mode of life being very obscure, and only a very small proportion exercising any influence, direct or indirect, upon man himself. An exception to the general rule, however, is the Silver Y Moth (*Plusia gamma)*, which scarcely any resident in the country can have failed to notice. It is almost unique among the lepidoptera in its habit of flying both by day and night, sporting round various flowers in the sunshine, and visiting the street-lamps after darkness sets in.

In the summer of 1879 a vast immigration of this insect took place in this country as well as in other parts of Europe. The moth was everywhere to be seen in countless numbers, flying up in thousands in every direction as one passed along, and sometimes almost bewildering one by its wonderful abundance. In other parts of Europe the insect was found in the same extraordinary plenty, and the swarm seems even to have extended to certain districts upon the African continent.

The name 'Silver Y' has been applied to this moth on account of the peculiar silver mark upon the forewings which closely resembles the English letter Y, or the Greek letter gamma (γ). Another moth of the same genus, the Golden Y (*P. iota*), has a mark of similar form, but of a golden instead of a silver hue. The whole genus is remarkable for the bright metallic patches which are found upon the wings of all the members, but which vary very greatly in form and colour in the different species.

The last *noctua* which we can mention is the handsome Red Underwing, a plentiful insect in the southern counties of England. When at rest, it is a comparatively commonplace insect in appearance, the markings of the upper wings being merely composed of a rather curious admixture of several shades of grey and brown. When the wings are spread, however, the full beauty of the moth is disclosed, the bright red under-wings affording a rich contrast to the grey and brown of the upper pair.

Except in flight, however, these wings are never shown, and the upper wings harmonize so exactly with the hues of the tree trunks upon which the insect generally rests, that it is perfectly invisible to any but the most practised eye. The moth is rather a large one, being rather more than three inches in spread of wing.

Next come a large number of moths, comprised in several families, which are collectively known as '*Micro-Lepidoptera,*' on account of the small size of most of the members. With the exception, perhaps of the Clothes Moth, which is only too familiar an insect to most of us, very few of these moths possess any general interest, and there is none amongst them which need be especially singled out for description. We will therefore bid adieu to the lepidoptera, and proceed, in the following paper, to the next order of insects, namely, the *Homoptera.*

No. XIII.—THE HOMOPTERA.

AS has already been mentioned in one of the earlier papers of this series, the *Homoptera* and the *Heteroptera* are often considered to form sub-orders only, being collectively known as *Hemiptera*. By those who follow this system they are respectively termed *Hemiptera-Homoptera*, and *Hemiptera-Heteroptera*. As, however, the distinguishing features of the two groups are very strongly marked, we will consider them as forming separate orders, to the first of which, the *Homoptera*, the present paper shall be devoted.

The *Homoptera* include a number of insects many of which appear to be totally dissimilar from one another, and it is not until we carefully examine the structural characteristics that we find them to possess any family resemblance. The distinguishing features of the order may be briefly summed up as follows.

In the first place, the structure of both the upper and the lower pairs of wings is of a similar nature, whence is derived the title of '*Homoptera*,' a word signifying 'same-winged,' and therefore very appropriate. These wings are membranous, the upper pair being slightly longer than the lower, which they entirely conceal when the insect is at rest. They do not overlap, however, the sutural margins running parallel with one another, just as is the case with the elytra of the *Coleoptera*.

The body is very convex, causing the wings to assume a rather curious position when not in use. This attitude is not easily described, but may readily be seen by an examination of one of the 'frog-hoppers' which are so plentiful in all parts of the country.

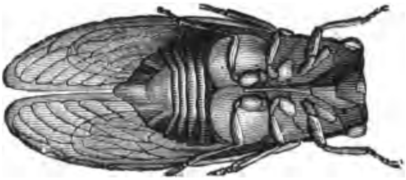
The mouth is situated on the lower surface of the head, and is furnished with a beak, or proboscis, by means of which the juices of the plants upon which the insect feeds can be imbibed into the system. This proboscis is merely a modification of the mandibles and the maxillæ, which are considerably elongated, and enclosed in the labrum, which forms a kind of sheath for the whole.

In all these insects the pupa is active, and generally bears a considerable resemblance to the perfect insect, the chief distinction, of course, lying in the absence of wings.

There is yet another characteristic of the insects of this order, however, and that a very important one, for upon it is based the present arrangement of the group. This is found in the structure of the tarsi, which, in the *Homoptera,* never consist of more than three joints. They may, however, have less, and Mr. Westwood has divided the insects of the order into three groups, namely, those which possess three joints in the tarsi, those which have two joints, and those in which one joint only is to be found.

The first of these groups is scientifically known as the *Trimera,* and is sub-divided into three families, of two only of which we have representatives in this country. In all the insects of this group the antennæ are very short, and are terminated by a slight bristle.

Of the first family, the *Cicadidæ,* we have only one British representative, and that solitary exception is so rare that it is very seldom seen, even by working entomologists. This insect, the lower surface of which is represented in the accompanying woodcut, possesses no popular title, probably on account of its rarity, but is scientifically known as *Cicada anglica.*



Cicada anglica.

Many of the foreign cicadas, that is, as far as the males are concerned, possess the faculty of uttering a very loud and shrill cry, which is audible at a considerable distance. This sound is produced by a pair of tightly-stretched membranes found beneath the thorax, which are protected by a horny plate easily visible upon examination.

It has not as yet been ascertained whether our British *cicada* is musical or not, although the probabilities are that it is so. It is true that a specimen of the male insect was kept in captivity for a couple of days without being heard to utter a sound, but this period of time cannot be considered sufficiently long to warrant us in coming to any definite conclusion upon the subject. It is much to be hoped that the next person who is fortunate enough to meet with a male *cicada* will endeavour to set this mooted point at rest.

The female *cicada* is furnished with an ovipositor of rather curious form, resembling a double spear with strongly serrated edges. By means of this instrument the insect is enabled to bore a hole in the substances in which her eggs are to be deposited.

The larva dwells in burrows in the earth, which it excavates by means of the very powerful fore-limbs. These tunnels sometimes extend to a considerable depth, some of the foreign cicadas sinking their habitations more than three feet into the ground.

The representation of the cicada which accompanies this description shows very clearly the peculiar form of the head, which is common to all the insects of the family to which it belongs, and also illustrates the manner in which the proboscis is packed away beneath the body when not required for use. The form of the body, too, is very well depicted, and, were it not for the size, the woodcut would serve as a very efficient illustration of the lower surface of almost any of our British *Trimera.*

Of the second family of this group, namely, the *Fulgoridæ*, or Lantern-flies, we have no British examples, and, as our space will not allow us to describe any of the foreign *homoptera*, we must pass to the third and last family of the *trimera*, namely, the *Cercopidæ.*

These insects are more familiarly known by the title of 'Frog-hoppers,' as they are popularly termed when they have arrived at the perfect stage of their development, and by that of 'Cuckoo-spit,' by which they are generally known while yet in the larval condition.

There must be few, indeed, who have ever possessed the use of a garden, or enjoyed a country walk during the summer months, who have not noticed the peculiar masses of frothy substance to be seen upon the stems of many plants, and which are frequently in such abundance as to completely drench the lower garments of the pedestrian

This frothy secretion is popularly considered to be composed either of the saliva of the cuckoo or of that of the frog, to which notion are owing the popular titles both of the larva and the perfect insect. In reality, it is formed in a very singular manner.

Driving its beak into the skin of its food-plant, the grub extracts the juices which constitute its nourishment. When they have passed through the system, these juices are exuded in the form of the frothy substance with which we are so familiar, and which covers the entire body of the larva. At occasional intervals the bubbles of which this frothy mass consists resolve themselves again into a liquid form, a drop every now and then falling to the ground, while another slowly takes its place, following the first, after a time, in like manner.

In the insects of this group the hinder limbs are formed for leaping, and are endowed with truly wonderful powers. It has been calculated that by their aid one of these Hoppers can leap to a distance equal to seventy times its own length; much the same as if a man were to spring over four hundred feet of ground at a single bound.

In order that they may be enabled to obtain a firm purchase upon the ground while preparing for these wonderful leaps, the hinder tibiæ are armed with a number of sharp spines, which afford the requisite foothold.

None of the insects of this division possess the curious sound-producing apparatus found in the *cicadas.*

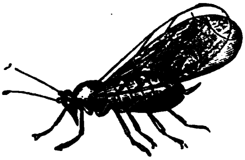
The most striking insect of this group is the Scarlet Hopper (*Cercopis sanguinolenta*), which may occasionally be seen resting on the leaves of the common bracken upon a sunny morning in the early summer. It is a remarkably handsome creature, which, once seen, can by no possibility be mistaken, the bold scarlet and black markings at once pointing it out from amongst its congeners.

Scarlet Hopper *(Cercopis sanguinolenta).*

This is by no means a rare insect, although it is very local, so much so, indeed, that it is often found to be confined to a few square yards of ground. Easily detected, on account of its brilliant colouring, it is by no means so readily captured, making one of its tremendous bounds at the slightest sign of approaching danger, and being quickly lost to sight among the herbage.

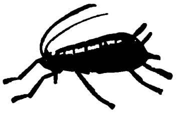
Many other frog-hoppers are known to inhabit this country, but they are, as a rule, so plain and insignificant to ordinary examination, and so similar to one another in their habits, that there is no necessity for us to expend space upon their description.

We will therefore pass to the next group of the *Homoptera*, namely, the *Dimera*, or those in which two joints only are found in the tarsi. This division includes the insects popularly known as Plant-lice, or Green Blight, and scientifically as *Aphidæ*, which are such terrible enemies to the horticulturist.



Aphis *(Winged form).*

These little insects are by no means formidable individually, but become so from the vast numbers in which they are found. They are wonderfully prolific, and that in a manner quite different from that which is customary with insects in general.



Aphis (*Apterous form*).

For, in these insects, the peculiar method of reproduction termed *Parthenogenesis* is strikingly exemplified. A female Aphis, kept entirely isolated from the other sex, will produce female young, and female young only, at the rate of fourteen or fifteen per diem, which, strange to say, pass through no preliminary stages of development, but are brought forth in a perfect condition, differing only in size from their parent. These in their turn give birth to a third generation, and so on. This strange method of reproduction has been known to extend over a space of several years, during the whole of which time no male aphis had been allowed access to the insects.

This will account for the wonderfully rapid rate at which the aphides increase, myriads appearing where only a few days previously not an example was to be seen. The birth of prolific females, of course, increases the reproductive powers to a wonderful extent, and there are few creatures which multiply with the extreme rapidity of the aphis.

Now and then the aphis does lay eggs, but this is the exception, and not the rule, the usual method of reproduction in this extraordinary insect being by the parthenogenesis above described.

Although individually one of these insects can scarcely do any appreciable harm to a plant, the extraordinary numbers of the aphides render them a most terrible pest to agriculturists. There are few plants or trees to which some species of aphis does not attach itself, and which do not suffer very considerably from the ceaseless persecutions of their tiny foes.

The hop, especially, is a particular favourite with these little insects, and, were it not for the attacks of the ladybirds, the lacewing-fly, and many other insects which find in them their principal food, the cultivation of this plant would be an absolute impossibility. Gardeners, also, know only too well the ravages caused by the 'blight' upon many of their favourite flowers, and vainly exhaust their energies in devising means to extirpate their destructive foes.

Yet, by a marvellous provision of nature, the enemies of the blight seem always to appear in proportion to the numbers of the pest. If our walls and windows are overrun with ladybirds, we may be sure that the blight has appeared in unusual numbers in the neighbourhood, and that its natural enemies have followed it in order to perform their appointed work of destruction. Sometimes, in the hop-grounds, these creatures may be seen literally in myriads, testifying by their numbers to the service they have rendered the agriculturist in destroying his terrible enemy.

The reader will remember that the frog-hoppers, which were described in the earlier portion of this article, exuded the vegetable juices which had passed through the system in the form of a mass of bubbles. The aphis behaves in a somewhat similar manner, ejecting the liquid through two minute tubes which project from the upper surface of the abdomen. The fluid, however, does not appear in the frothy form with which we are familiar in the case of the frog-hoppers, but is merely distilled into limpid drops of liquid, which successively fall upon the leaves on which the insect is resting.

This 'honeydew,' as it is termed from its sweetness, is a favourite beverage with ants, which, strange as it may appear, actually carry the aphides off to their nests, in order to procure an unfailing supply of the coveted dainty. Very often an ant may be seen upon the leaf of some plant or tree tapping an aphis gently with its antennæ, in order to induce the insect to exude a drop of the saccharine fluid, which is eagerly licked up as soon as it makes its appearance at the extremity of the abdominal tubes.

It is also said that the ants are in the habit of guarding their herds from the attacks of the hymenopterous parasites which are constantly seeking an opportunity of depositing their eggs in the bodies of their victims, and that they are always on the watch for the appearance of the winged parasite.

There are several kinds of aphis to be found in this country, but as all are very similar in habits it is needless to particularize any one species.

Closely allied to the preceding insects are those curious aphides which have received the generic title of ***Eriosoma***, ***i.e.***, 'wool-bodied,' for the reason that their bodies are covered with a substance resembling fine cotton wool. These creatures are popularly known as American Blight.

The woolly substance with which the bodies of these aphides is covered far exceeds in bulk the insects themselves, which it renders so light in proportion to their size that they are blown hither and thither by the least gust of wind. Should they once find their way to the branches of an apple-tree, the fate of that tree is sealed, unless immediate measures are taken for the extermination of the pest. Creeping into the crevices of the bark, the insects form a settlement, and quickly make their way over the entire tree, which speedily becomes overspread with the white cottony substance which covers the bodies of the aphides. Before very long, the tree fades, withers, and finally dies; why, no one can tell.

Mr. E. Newman tells us, in his well-known 'Letters of Rusticus,' that the only way of extirpating this destructive pest is by the free application of melted size to the affected trees, not even the smallest patch of the woolly substance being allowed to escape. This, he says, is far superior to the whitewash used in many orchards, which, besides being comparatively ineffectual, completely ruins the appearance of the trees.

In the winter-time the aphides retire to the earth at the foot of the tree in order to gain protection from the chilling cold. It is then advisable to turn over an inch or so of the soil upon every frosty day in order that the concealed insects may be killed by the exposure to the cold.

These aphides are not furnished with the abdominal tubes through which the honey-dew is distilled, that liquid being produced only by the insects of the preceding group.

The last of the three groups of the *Homoptera* consists of the *Monomera*, or those in which the tarsus is composed of a single joint only. These creatures, which are popularly known as Scale Insects, or Mealy Bugs, and scientifically as *Cocci*, are all included in a single genus.

These are in many ways most extraordinary insects, the females especially seeming actually to *deteriorate* as they approach the perfect condition. Indeed, when the final stage of their development is attained, the female *cocci* become, as Mr. Westwood justly remarks, more like galls than living creatures, 'losing all trace of articulation in the body as well as of articulated limbs, and leaving inert and fixed masses of animal matter, motionless, and apparently senseless.'

During the earlier stages of their development the sexes are very similar in appearance, both being very active at this period of their existence. After some little time they insert their beaks into the bark of some twig, or the veining of a leaf, and remain motionless, increasing, meanwhile, very rapidly in size. In this position they pass the winter, at the end of which the males take to themselves wings, and fly away in search of their mates, while the females remain fixed as before.

The male *coccus* presents a very different appearance from his obese and unwieldy mate, being really quite a handsome insect. The body is of a deep red colour, while the two wings are of an opaque white, edged with a band of deep crimson. He is very much smaller than the female, and, indeed, presents so totally different an appearance that the two would never be taken for the same species.

The eggs deposited by the female are about two thousand in number, and are enveloped in a kind of woolly substance which entirely conceals them from view. As soon as they are laid the parent insect dies, her body flattens and becomes shrivelled and hard, and forms a kind of covering for the eggs, which are situated beneath it.

The British *cocci* are terrible nuisances to the gardener, more especially in hot-houses, where they wreak considerable havoc among the flowers. Some of the foreign species, however, are directly useful to mankind, the well-known Cochineal Insect (*Coccus cacti*) being one of these. From another species, the Lac Insect (*C lacca*) we obtain our sealing-wax, and a peculiar kind of wax from a third, *C. ceriferus.* The British species, however, have as yet been brought to no practical use.

No. XIV.—THE HETEROPTERA.

THE *Heteroptera*, or, according to some systems, the *Hemiptera-Heteroptera*, differ from the *Homoptera* chiefly in the structure of the wings, which, in those species that possess them, are of two different textures, the basal portion of each being hard and leathery, while the remainder is membranous and semi-transparent. Hence is derived the title of *Heteroptera*, which signifies 'different-winged.'

In the *Heteroptera*, the wings slightly overlap when the insect is at rest, instead of running parallel to one another at the suture, as is the case with the *Homoptera.*

Amongst the other distinguishing features of the group, we may mention the form of the body, which is flattened, and not convex, and also the position of the proboscis, which starts from the front of the under surface of the head, instead of from the back.

In many of the *Heteroptera* the wings are scarcely visible, being, indeed, nothing more than mere rudiments of those organs, while in others they are only developed in a very slight degree, and are utterly useless for purposes of flight. In some species we meet with a rather curious phenomenon, the vast majority of specimens being apterous, while an example occasionally appears in which the wings are fully developed.

The *Heteroptera* are sub divided into two great groups, known respectively as *Gymnocerata* and

Cryptocerata. The former of these titles signifies, 'apparent-horned,' and refers to the antennæ, which, in the insects belonging to this group, are long, and are easily seen. This is not the case, however, with the members of the second group, in which the antennæ are very small, and are not visible except upon close examination. The title of *Cryptocerata*, or 'hidden-horned,' which has been applied to them, is, therefore, very appropriate.

In Mr. Westwood's arrangement these two groups are termed *Aurocorisa* and *Hydrocorisa.* The former of these two titles signifies 'air-bugs,' all the insects of the group being dwellers either upon the earth or the surface of the water, beneath the surface of which, however, they are not in the habit of living. But the *Hydrocorisa*, or 'water-bugs,' are all inhabitants of the water itself, passing the greater portion of their existence beneath the surface, and only rising occasionally in order to obtain a supply of air.

A very conspicuous member of the former group is the insect scientifically known as *Tropicoris rufipes*, but which possesses no popular title. In common with many of its congeners, however, it is often termed a 'Bishop's Mitre,' in consequence of the peculiar form of the body.

This insect is very common towards the end of summer, and may often be seen resting on palings, etc., or on the herbage by the roadside; the brilliant red spot at the apex of the scutellum rendering it a very striking object. The general colour is brown, prettily mottled with black, while the beak, the antennæ, and the legs are of a bright red.

In common with many members of the group the *Tropicoris* possesses a powerful and singularly unpleasant smell, which, if the insect be handled, will cling to the fingers for a considerable time, in spite of repeated lavations. This disagreeable odour is also transmitted to the substances over which the insect walks, fruit of various kinds being often tainted to such a degree as to be rendered perfectly uneatable.

It is, however, under the control of the insect, which can exude or retain it at will. It is due to a fluid which passes from two small pores in the hinder tarsi, so that if the insect be carefully seized by the sides of the body, in such a manner that the feet cannot come into contact with the skin, it can be handled with perfect impunity.

The odour still clings to the insect for many months after death, and often renders the drawer in which the specimens are contained most terribly offensive to the olfactory organs.

The common bed bug *(Acanthia lectularia)* is also a member of this group. This is one of the apterous species of *Heteroptera*, the wings being only represented by two very small projections in the place of those organs.

This only too familiar insect is not an indigenous inhabitant of England, but is supposed to have been introduced into this country in the course of the last two or three hundred years; from whence, however, we cannot ascertain with any degree of certainty. Once imported, it spread with marvellous rapidity, rivalling the cockroach itself in the speedy manner in which it made its way even to the most remote parts of the country.

When once it has taken up its quarters in a room, the bed bug is a most difficult creature to disestablish, its small size and flat body enabling it to creep into the smallest crevices. Within these chinks are deposited the eggs, some fifty or sixty in number, which are always covered with a kind of varnish which hardens upon exposure to the atmosphere, and so fixes them securely to the substance upon which they are laid.

The most successful method of destroying these disagreeable insects appears to consist in burning large quantities of sulphur in the room in which they have taken up their residence, having previously stopped up every aperture through which the fatal vapour can possibly escape. After a few weeks the process must be repeated, in order to destroy those specimens which have emerged from the egg subsequently to the former campaign.

Passing over a large number of insects, which are of little interest except to those making a special study of the order, we come to the curious group which pass their existence upon the surface of the water, over which they can glide with considerable speed. These are known in science as *Hydrometridæ*, or 'water-measurers,' and are so called because they seem to measure the surface of the water with their wonderfully long and slender limbs. Popularly they are known as Water-gnats, bearing, as they do, some little resemblance to a gnat from which the wings have been removed. They are to be seen in great numbers in almost every pond, passing along over the surface of the water with astonishing speed.

Water-gnat (*Gerris lacustris*).

The fore-limbs do not appear to be employed for purposes of locomotion, but are stretched out in front of the body for the purpose of seizing prey. The hinder legs seem to act chiefly in directing the course, while upon the middle pair falls the task of propulsion.

In many specimens of water-gnats the wings are not developed, but remain in a rudimentary condition throughout the insect's existence. In others, however, they attain their full dimensions, and are quite capable of bearing their owner through the air. Upon alighting after an aerial excursion, the long hind limbs are employed in tucking the wings beneath the elytra.

Included in the *Gymnocerata*, although not in Mr. Westwood's group of the *Aurocorisa*, are two very curious and interesting insects, each of which will be described in turn.

The first of these is the extraordinary creature known as *Ranatra linearis*, which would by very few people be recognised as an insect at all. In general appearance it is not unlike a gigantic water-gnat, from which insect, however, it differs in the two long bristle-like appendages springing from the end of the body. Its total length, measured from the extremity of the fore-legs, when fully stretched out, to the end of the bristle-like appendages at the tail, is rather more than three and a half inches, while the extreme width of the body is nowhere greater than one-seventh of an inch. The dull brown colour, slender body, and long limbs render the insect very far from conspicuous amongst the weeds of its native pond, and, until it moves, the creature can hardly be distinguished from the stems of the plants amongst which it is resting.

The *ranatra*, unlike the water-gnats, spends the greater part of its existence beneath the surface of the water, progressing by means of the two hinder pairs of legs. The fore-limbs seem to be used for the purpose of seizing prey alone, and are formed more like jaws than legs; so much so, indeed, that they would certainly be mistaken for those organs by any but an experienced observer.

The eggs of the *ranatra* are deposited in a very singular manner, which has been described by a correspondent of 'Science Gossip,' for November, 1879. He says: 'On July 7, I was much surprised to find the leaf of frog-bit exhibiting a most unusual appearance; the best verbal description that I can give of this appearance is, that the floating leaf appeared on the top to possess the antennæ of some moth, to which underneath was attached a small substance, something in shape like a canary seed, but more rounded at the extremities, especially at the end from which these antennæ or appanages spring. The leaf had evidently been pierced, and the appanages thrust through, which, opening into a V-like shape, kept the underneath substance from falling.

'I was much puzzled by these appearances, and being quite ignorant of what they were, called in one or two friends to see them, in the hope of acquiring information; but being unable to get any I then more anxiously watched, and almost came to the conclusion that they were the germs of some botanical production.

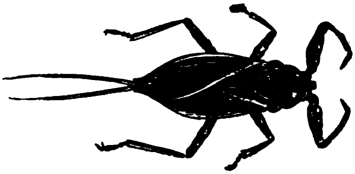
'The leaf of the frog-bit decaying they gradually sank, the same V-like appanage which had kept them in their position now keeping them from falling too fast or from sinking in the soft mud at the bottom of the aquarium; here they remained in a perpendicular position, and were watched from time to time. On August 4th I was delighted to find four young *ranatra* swimming freely about. They were about half an inch in length, and in form so like their parents that it was impossible to be deceived.

'The appearance of these young *ranatra* led to the discovery that the objects on the leaf of the frog-bit which had so puzzled me were the ova of this insect, for I found them all on the bottom of the aquarium quite empty, with an opening in the end between the antennæ or appanages.

'I cannot help thinking what an interesting sight it must have been to have watched the insect depositing the ova, how the leaf must have been pierced, the ova extended, the antennæ—if they may be so called—being thrust through the perforated opening, on which they must immediately have sprung into a wedge-like shape—opening wide at the top—to keep the ova in position.'

The *ranatra* is not a very common insect, but may be found in ponds and ditches in many parts of the country.

Belonging to the same family as the *ranatra* is a very different-looking insect, namely, the common Water-scorpion (*Nepa cinerea*). A very good idea of the general appearance of this insect may be obtained by a reference to the accompanying illustration, in which the flat, leaf-like body, the jaw-like fore-legs, and the appendages at the end of the body are very well depicted. The fore-limbs closely resemble those of the *ranatra*, and are used for a like purpose, namely, that of securing prey.



Water-scorpion (*Nepa cinerea*).

Were it not for the powerful likeness which it bears to the dead leaves and other *débris* found at the bottom of every pond the water-scorpion would find great difficulty in obtaining food, for its motions are far more sluggish than those of the water-insects, etc., upon which it preys. But, aided by its resemblance to surrounding objects, the insect waits patiently until some luckless victim comes within reach, when it is at once seized by the outspread fore-legs, conveyed to the mouth, and its juices strained by means of the sharp proboscis.

The filaments at the end of the tail serve to convey air to the spiracles, which are placed at the end of the body, when the insect is beneath the water, the extremities of those appendages just appearing above the surface while their owner is altogether submerged. Those of the *ranatra* answer the same purpose.

The eggs of the water-scorpion are of a very singular form, being furnished with seven horn-like projections, arranged in a circle, by means of which they are fastened to the leaves of various water-plants, just as is the case with those of the preceding insect.

Although the water-scorpion almost invariably seeks its prey beneath the water, I know of one case, which came under my personal observation, in which there was an exception to this rule.

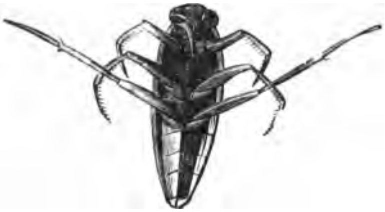
While standing, one warm summer's day, upon the banks of a small pond, which had been partly dried by the heat of the weather, I noticed a fly struggling in the mud which surrounded the edge of the water, and apparently in the grasp of some invisible adversary. Upon investigating the matter, I found that a water-scorpion had buried itself in the mud, with the jaws just projecting above the surface, and had seized the fly as it passed along unconscious of the presence of its enemy. The whole proceeding, in fact, bore a considerable resemblance to the mode of capture of prey followed by the ant-lion.

Although a very dull and sombre-looking insect when creeping slowly amongst the *débris* of the pond, the water-scorpion is really quite a handsome creature when the wings are spread in flight. The basal portions of the lower pair, as well as the greater part of the upper surface of the abdomen, are then seen to be of a brilliant red colour, which really renders the insect a striking object.

The water-scorpion is a very plentiful insect, and may be taken in numbers from any weedy pond.

Now we come to the second of the two great groups of *Heteroptera*, namely, the *Cryptocerata*, or those in which the antennæ are concealed from view. The most interesting of these, perhaps, is the common Water-boatman (*Notonecta glauca*), which we will accordingly take as a type of the group.

In the accompanying woodcut the position generally assumed by the boatman when swimming, or resting upon the surface of the water is very well represented. In this curiously reversed position the insect passes the greater part of its existence in the water, and may be seen in numbers in almost any pond, resting motionless upon the surface of the water, unless disturbed by the shadow of a passer-by. Sometimes, however, on a fine and sunny morning, the boatman will turn over, and assume a rather remark-



Water-boatman (*Notonecta glauca*).

able attitude, resting upon the surface of the water with the elytra opened and the wings partially protruding.

The name of 'boatman' is wonderfully appropriate, the insect, in its reversed position, bearing a most striking resemblance to a boat with two long oars projecting from it. And the long hind limbs really take the place and fulfil the functions of oars, being fringed with long hairs, just as is the case with those of the *Dyticus* and other aquatic beetles, in order that they may offer a greater resistance to the water. The term '*Notonecta*' is also appropriate, that word signifying a 'back-swimmer,' and referring to the attitude assumed by the insect when in the water.

The 'feathering' principle, if we may so call it, of the swimming legs, is also quite as strongly marked as in the water-beetles, the limb mechanically turning sideways for the reverse stroke, and so presenting the edge only to the water, through which it cleaves without difficulty.

The respiratory system, too, is of much the same order, the space between the wings and the abdomen forming a kind of reservoir for the reception of air. Thus provided, the insect can spend a considerable time beneath the water without requiring to seek the surface in order to procure a fresh supply.

The wings of the *notonecta* are large and powerful, and are well adapted to bear their owner through the air. The insect is able to take to flight from the surface of the water, which it does as follows:

First, diving to some little distance, it reverses its position so as to bring its head upwards; then, swimming rapidly towards the surface, it gives a smart stroke with the hinder legs, and so projects itself a few inches into the air. The wings are then immediately spread, and the insect flies off before it has time to fall back into the water.

(Some years ago, I had a number of water-boatmen in an aquarium. Seeing, to my great surprise, that they took to wing from the surface of the water, I leaned over the aquarium and looked into it. Presently, one of the insects dived, as has just been mentioned, sprang into the air, struck me on the nose, and fell back into the water. I wonder which was the more surprised, the insect or myself.—J. G. WOOD.)

The water-boatman is a very predacious creature, and seems to possess a particular fondness for the water-gnats, which it captures without difficulty as they are resting upon the surface of the water. In a very few moments the body is drained of its juices, and the boatman casts it aside and looks out for another victim.

The proboscis of the water-boatman is very sharp and strong, and is capable of inflicting a rather painful wound upon the fingers if the insect be not properly held. The saliva appears to possess a decidedly poisonous quality, as the wounded finger will swell and ache for hours in a manner which could scarcely be caused by the puncture alone.

Both the larva and pupa of the water-boatman bear a very strong resemblance to the perfect insect, from which, however, they can easily be distinguished by the absence of wings. In the former stage of development these organs are altogether wanting, while in the pupa they are quite rudimentary in size.

Closely allied to the water-boatman are a number of insects included under the generic title of *Corixa*, many of which are exceedingly plentiful in every pond. In habits and general appearance these little creatures closely resemble the preceding insect, from which they may be distinguished by several points of structure, such as the form of the body, which is flat instead of convex, etc.

No. XV.—THE DIPTERA.

BETWEEN the *Homoptera* and the *Diptera* is placed the small and comparatively unimportant order of the *Aphaniptera*, the members of which are popularly known as Fleas.

The word *Aphaniptera* signifies 'non-appearing wings,' and is a very appropriate title, the organs of flight being utterly useless for their legitimate purpose, and being merely represented by four extremely minute scales upon the thorax. So small are these scales, indeed, that they can only be seen by means of a high power of the microscope, and even then are so unlike the wings of other insects that their real nature would scarcely be imagined except by an entomologist experienced in insect anatomy.

Space being unfortunately limited, we can devote but a few lines to this order, which, although unimportant and comprising comparatively few members, yet affords us many features of interest. We will therefore pass to the *Diptera*, or two-winged flies, which constitute the last order in the present classification of the insect world.

The word '*Diptera*' is not as appropriate a title as might be desired, being of a rather misleading nature. It is true that in the insects of this group two wings only are visible upon a cursory examination. But this is in outward seeming only, for all four wings are present, although the lower pair are found in a curiously modified form. Few, indeed, would recognise these for wings, or modifications of wings at all, the two tiny bristles, each tipped with a small round knob, apparently having nothing in common with the broad, membranous organs which bear their owner so swiftly through the air.

Yet, small and unimportant as these '*halteres*,' or 'balancers' appear, they yet seem to be of vital importance in the flight of the insect, for it has been found that if they be removed, or otherwise damaged, their owner loses the power of directing its course, and can only flutter helplessly along the ground, like some moth whose too inquisitive turn of mind has led it to practically experience the properties of a gas-flame. Even in many Diptera, whose upper wings are only rudimentary, the halteres are present, which would lead us to suppose that they have other functions besides that of assisting in flight, and of which we can form no conjecture.

The upper pair of wings are of much the same nature as are those of a bee or wasp, but have at their bases two small appendages, looking somewhat like an additional pair of rudimentary wings. These are generally known as 'alulets,' or winglets, the object of which is not clearly understood.

Professor Westwood has divided the *Diptera* into two great sections; the first of these he terms *Cephalota*, the head being distinct from the thorax instead of being sunk into it. This group he again divides into smaller families, the *Nemocera*, or 'thread-horned' flies holding the first place in his arrangement. In the insects of this group the antennæ are composed of more than six joints, the palpi having either four or five joints.

This division includes some of the most widely and universally familiar of all of our British *Diptera*, namely, the gnat and the daddy-longlegs.

In spite of certain unpleasant features in the character of each, both these insects are of wonderful interest, and will repay the most careful and protracted examination which can be bestowed upon them. We will begin with the former, known scientifically as *Culex pipiens.*

Excepting by those favoured individuals who are exempt from its attacks, the gnat is generally regarded as an insect whose sole mission in life is to torment the human race, and therefore as one which should be discouraged in every possible way. And yet, like many other creatures placed in the same category, the gnat is far less black than it is painted, and, indeed, by the nature of its food during the earlier stages of its existence, actually confers a benefit upon mankind by preventing miasma from arising from the putrid substances found in the stagnant ponds in which it dwells.

The life-history of the gnat is of a most wonderfully interesting nature, from the moment at which the eggs are deposited by the parent until that when the perfect insect emerges from its pupal shell, and soars aloft to make its first journey through the air, of which, for the remainder of its existence, it is to be an inmate.

To begin with, the eggs are deposited upon the surface of the water in a very singular manner. Resting upon some small twig, or other floating object, the parent gnat crosses her long hind legs behind her, and places a single egg in the angle formed by their junction. This egg, which is long and spindle-shaped, is then transferred to the water, where it floats upright, little more than half being actually submerged. A second follows in a like manner, and is firmly fastened to its predecessor by some cement which is not affected by the action of water. This is in its turn followed by a third, and so on until the whole number of its eggs is deposited.

When this is the case, the egg-mass is seen to form a kind of boat, much resembling a carraway seed, both in size and appearance. This floats upon the surface of the water, and, by the peculiar method of its construction, can neither be sunk nor upset. It may be forcibly submerged, but will return to the surface immediately upon being released, and, discharging the water which it had taken in, at once regain its former position. Indeed, the whole structure of the egg-boat of the gnat is so exactly that of the present self-righting lifeboats that we cannot but wonder whether the inventor of the latter did not take a lesson from nature, and build his boat upon the principles of one which probably existed long before man came upon the face of the earth.

After the expiration of a few days a small door, so to speak, opens in the submerged end of each egg, and the young gnat larva dives into the water which is to form its home throughout the earlier stages of its existence.

The appearance of the young grub is rather remarkable, the head being very large when compared with the size of the body, and the tail furnished with a forked appendage, connected with the respiratory apparatus. These larvæ may be found in numbers during the summer months in any stagnant pool or ditch.

In due course the larva passes into the next stage of its development, and becomes a pupa. It is still able to travel through the water as before, but can no longer take food, all the organs of the mouth being enveloped in the outer covering. After a short time, the pupal skin cracks along the back, and the perfect insect slowly emerges, using its late covering as a kind of raft upon which to rest until the wings have attained their full strength, and are able to bear their owner into the air.

Just as is the case with the bee and wasp, and other stinging *Hymenoptera*, the male gnat is altogether harmless, and is quite incapable of inflicting the unpleasant wounds caused by his gentle spouse. The distinction between the sexes in outward appearances is evident even to a casual observer, for the antennæ of the male are beautifully plumed for almost the whole of their length, while in the female these organs are feathered only in a very slight degree.

The apparatus by which the female gnat inflicts the wounds which cause her to be regarded with so great abhorrence by the victims of her attacks is of a rather complicated nature, and cannot be very easily described by words alone. The beak consists of no less than seven separate parts, which are, in fact, modifications of the different parts of the mouth, and are not supplementary organs, as is generally supposed to be the case. The upper lip becomes a broad and hollow lancet: the mandibles are developed into long serrated organs, adapted for the purpose of piercing the skin; the maxillæ are somewhat similar in form, but are very much more slender and delicate; the tongue, again, is represented by a very long and needle-like instrument, while the lower lip forms a kind of sheath which encloses these various weapons when not in use.

The peculiar irritation caused by the bite of the gnat is due to the saliva, a small portion of which is introduced into the wound by the insect in order to cause the blood to flow more freely. This acts with greater or less severity upon different individuals, some suffering greatly from the bite of the insect, while others seem little, if at all, annoyed by the wound.

When placed beneath a tolerably high power of the microscope, the gnat becomes a most wonderful and beautiful object, fully repaying any care and attention which may be expended upon its examination. The wings, the body, the limbs, and even the beak itself, are seen to be covered more or less closely with beautiful scales, very much resembling those of the Lepidopterous insects which have been described in preceding papers of this series. All the colours of the rainbow seem to play over the body, while new glories show themselves at each fresh glance, giving the observer some slight and imperfect idea of the wonderful beauties to be found even in the commonest and most despised of the inhabitants of the insect world.

The well-known Daddy-long-legs, or Crane-fly (*Tipula longicornis*), must be ranked amongst those insects which are directly injurious to man, the larvæ feeding upon the roots of various grasses, which in some cases they so destroy that the turf may be rolled up by the hand as readily as if it had never been attached to the ground beneath. Indeed, were it not for their natural enemy, the starling, the damage caused by these grubs would be altogether incalculable, and would well entitle them to take rank amongst the bitterest foes to our lawns and pasture-land. Even as it is, they are quite destructive enough, and in some seasons swarm to such a degree that acres upon acres of grass land are completely ruined by their depredations.

There are many species of crane-flies, some of which, like the gnat, are inhabitants of the water until they attain to their perfect condition. In one genus, *Chironomus*, these grubs are of a bright scarlet colour, and are sometimes the cause of a somewhat peculiar, and at first sight mysterious, phenomenon. In damp and marshy ground, perhaps a small pool or two may be seen in which the water appears to be of a dull reddish colour, just as though a considerable quantity of blood had been mingled with the contents. As the observer approaches, this red hue suddenly vanishes, and the water assumes its normal appearance. Should he remain quiet, however, the reddish colour gradually returns, until the pool appears just the same as before his approach.

This strange phenomenon is due to the scarlet grubs of the *Chironomus*, which are present in such numbers as apparently to redden the water of the pool. At the least sign of danger they dive into the mud beneath, remaining there until quiet is again restored.

THE next division of the Cephalote *Diptera* is known as the *Brachocera*, a word signifying 'short-horned.' In these flies the antennæ never consists of more than three joints, while two, and in some cases one only, are found in the palpi.

A well-known member of this group is the Gad-fly (*Tabanus bovinus*), which forms so great an enemy to cattle in this country. It does not, however, confine its attacks to these animals alone, but often forms a very unpleasant foe to man himself, driving its long and sharply-pointed lancets into his skin, and inflicting a decidedly painful wound. As is the case with the gnat, the male is harmless, all these unpleasant attacks proceeding from the female alone.

On account of its wonderful likeness to a bee, the Drone-fly (*Eristalis tenax*) would scarcely be taken for a dipterous insect at all, and there are few people who would care to handle a specimen until they were thoroughly assured that the resemblance ended with its outward appearance.

The chief interest of the drone-fly lies in the larval stage of its development, at which period of its existence it is certainly a most wonderful creature. It is then known as the Rat-tailed Maggot, a title which it derives from the very curious formation of the respiratory organs.

Dwelling, as it does, immersed in the most fetid and noisome mud which can well be imagined, the requisite supply of air would seem to be utterly unattainable. But this difficulty is overcome by the remarkable structure of the tail, through which the breathing tubes run, and which bears a wonderful resemblance to a telescope, being capable of considerable expansion and contraction. Thus, although the whole body may be completely buried in the mud, the extremity of the tail can yet project above the surface, so that a constant supply of air is assured to the larva.

Should any signs of danger appear, this telescopic tail is instantly contracted, and does not resume its functions for some little time.

Taking into consideration the nature of its food, we may rank the drone-fly amongst our more particular insect benefactors, for there can be no doubt that by its agency a vast quantity of putrid matter is annually consumed which would otherwise in all probability give rise to miasma, and so cause fevers and agues to a very considerable extent.

When the time for its change to the pupal condition approaches, the drone-fly larva emerges from the mud which has previously formed its home, crawls ashore, and buries itself in the ground, whence the perfect insect emerges in due time. The fly is extremely plentiful, and may be found in great numbers throughout the summer and early autumn, either hovering over flowers, or basking in the warm rays of the sun.

Passing of necessity by many very interesting insects, we come to the vast family of the *Muscidæ*, more than a thousand species of which are known to inhabit Great Britain alone. Of these we will take two or three examples, the first of which shall be the common and well-known Blue-bottle, or Blow-fly (*Musca vomitoria*).

This is another of the many insects which are popularly supposed to be created for the sole purpose of annoying mankind, whereas in reality their services can scarcely be over-valued. It is true enough that the blow-fly is very troublesome in our larders during the heat of the summer, but, if we set this trifling annoyance in the scale against the great benefits which it confers upon us in other ways, we shall see that it ought in reality to be placed in the foremost rank of our insect friends.

For the blow-fly is one of the most untiring coadjutors of the burying beetles, the cocktails, and the various other insects whose larvæ find their food in decaying animal matter, and which ought, therefore, to be protected and encouraged to the utmost of our power.

No sooner does any neglected animal matter show the least signs of incipient decomposition, than the blow-fly, together with its many assistants, makes its way to the spot, and commences its beneficent work by depositing a vast quantity of eggs. These very shortly hatch, and the young grubs immediately begin upon the great business of their lives, viz., that of eating, from which they never cease until the time arrives for them to assume the pupal form. They then bury themselves in the ground, and become hard, cylindrical, brown objects, not quite a quarter of an inch in length. In a wonderfully short time the perfect insects emerge, and at once set off in search of sustenance for the next generation.

The Flesh-fly (*Musca carnaria*) greatly resembles the blow-fly in habits and life-history, differing from it, however, in one important particular. For, while the blow-fly places eggs upon the putrid matter which it selects as food for its future offspring, the flesh-fly deposits living larvæ, these having hatched within the body of the parent. If the abdomen of a flesh-fly be opened, these grubs may be seen lying in two long rolls, each of which contains some five thousand larvæ.

The wonderfully rapid rate at which these flies multiply may thus be imagined, and when we reflect that the entire development of the insect is completed in the course of a day or two, we can understand the remark made by Linnæus, that three flies could eat an ox as fast as a lion.

Many of the *Muscidæ* are parasitic within the bodies of various caterpillars, just as is the case with the Ichneumon flies described in a previous article.

We must not omit to mention the well-known Bot-flies (*Œstridæ*), so familiar to us from their parasitic attacks upon various animals

One of the most plentiful of these is the common bot-fly (*Gasterophilus equi*), which always selects the horse as the victim of its attacks.

The egg is placed by the parent insect upon some hair within easy reach of the horse's tongue. Before long, the spot is licked by the animal, and the egg carried into the mouth, whence it shortly passes to the stomach. Here the grub emerges, and seems to feed upon the secretions of that organ.

During the winter it remains within the body of the horse, but in the spring loosens its hold, passes through the intestines, and makes its way to the ground, in which it burrows in order to assume the pupal condition.

It is a mooted point whether these larvæ, many hundreds of which may often be seen within the stomach of a single horse, are productive of harm to the animal. It can hardly be supposed that their presence within the body can be beneficial, and yet it is impossible to detect any actual harm caused by their parasitic habits. As, however, it would seem that they must extract a certain amount of nourishment from the secretions of the stomach, we can only conclude that they must, although, perhaps, in only a slight degree, weaken the animal in whose body they have taken up their abode.

A curious memorandum with regard to this group of *Diptera* occurs in the *Entomologist* for July of the present year (Ent. xv. 164):—'At one of the meetings of the International Medical Congress, Dr. W. G. George stated that a girl, aged twelve, presented herself with the following history:—About three months before being seen by a medical man an ovoid swelling appeared on the outer side of the ankle, causing her some pain and uneasiness in walking. This swelling gradually shifted its position, and slowly moved up the leg, thence towards the right axilla, then down to the elbow, and finally settled on the back of the neck. In this position a small dark spot appeared, an orifice formed; and when pressure was made around this opening, a white grub, nearly an inch in length, protruded, and escaped along with some unhealthy pus. Several other similar swellings developed upon subsequent occasions under medical observation, and the medical man extracted other grubs, exactly similar to the first specimen. No cause could be assigned for these curious phenomena. The larvæ were pronounced by competent authority to belong to a dipterous insect, although the genus could not be satisfactorily determined. There was no sufficient proof of the existence of an *Œstrus* peculiar to man alone.'

We must now pass to the second of the great divisions of the *Diptera*, namely, the *Thoracocephala*, or those in which the head is buried in the thorax.

Space will allow us to describe one member only of this group, namely, the common Horse-fly (*Hippobosca equina*).

This insect, which torments horses so greatly by its determined attacks, is chiefly remarkable for its extraordinary method of reproduction. It will be remembered that in the flesh-fly above described the eggs are hatched within the body of the parent insect. In the horse-fly, however, whose offspring is limited to one, the whole growth of the larva takes place before it enters the world, in which it makes its appearance in the pupal form. This strange method of reproduction appears to be confined to this group of insects.

We have now arrived at the end of our task, and have given a short and necessarily incomplete sketch of the insect world. In conclusion we have only to hope that some few of our readers may be induced to take up for themselves a study which is second to none in the beauty of its objects, the interest of their life-history, and the wonderful and yet simple nature of their structure; and we feel certain that none who may do so will ever find cause to regret their determination.

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